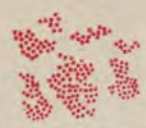
Fig. 1.

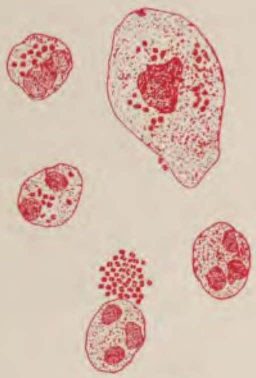


Staphylococcus pyogenes aureus.

Fig. 2.

Streptococcus pyogenes.

Fig. 3.

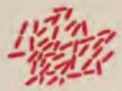


Gonococcus.

Fig. 4.

Micrococcus lanceolatus.

Fig. 5.



Bacillus coli communis.

Fig. 6.

Bacillus pyocyaneus.

Fig. 7.

Bacillus tetani.

Fig. 8.

Bacillus tuberculosis.

ASEPTIC SURGICAL TECHNIQUE

With Especial Reference to Gynæcological Operations, together with Notes on the Technique Employed in Certain Supplementary Procedures

BY

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TO

HOWARD A. KELLY

PROFESSOR OF GYNÆCOLOGY, JOHNS HOPKINS UNIVERSITY

PREFACE TO THE THIRD EDITION, REVISED.

In the revised third edition of this book the majority of the changes deal with certain modifications that we have found practicable and consistent in the technique of operative work. Several new and original illustrations have also been added.

HUNTER ROBB.

CLEVELAND, May, 1906.

PREFACE TO THE FIRST EDITION.

In preparing this book I have availed myself of the writings of my predecessors in this field, and have gathered much from their work, especially from that of Schimmelbusch, Terrillon, and Sänger. The technique recommended is in the main that practised in the gynæcological and surgical departments of the Johns Hopkins Hospital.

I have to express my sincere thanks to Professor Welch, to Dr. L. F. Barker, and others for kind suggestions, and to Dr. F. R. Smith for the revision of the manuscript.

BALTIMORE, June, 1894.

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INTRODUCTION.

I do not think any student of the history of medicine will for a moment dispute the assertion that the importance of the changes wrought in our surgical technique within the past ten years is unparalleled by that of any previous century of medical or surgical progress.

Those changes which were inaugurated with the recognition of the infectious nature of wound-inflammation were distinctly revolutionary, while the changes of the more immediate past have been evolutionary in character; accepting the germ theory as the working principle, the object of our toilers in the field of original research has been the elaboration of a method by which these enemies to successful surgery might be eliminated from the field.

This direct application of the principle in the practical field has been but recently satisfactorily established after numerous experiments conducted in the laboratory upon animals and tested upon patients in the operating-room.

Only by a slow process, considering the vast number of experiments conducted in all our hospitals, have we grown out of an antisepsis of toxic drugs into the

simpler antisepsis of moist heat and saponaceous detergents.

Throughout these momentous changes in the surgical arena Dr. Robb has been a faithful observer, and not an observer only, but frequently an active participant, assisting the evolution of the new idea, constantly following the work of others, repeating their experiments, and performing experiments of his own, notably in connection with my own work, which have been valuable in aiding the progress of the technique step by step until it has attained its present position. It was Dr. Robb's work in relation to disinfection by permanganate of potassium and oxalic acid which first established on a scientific basis the reliability of this method when applied to the hands. His studies regarding the infection of the drainage-tube tract are also notable.

It is therefore on account of his labors in the bacteriological laboratory, while keeping himself at the same time constantly in close relation to the eminently practical surgical questions of the day during a decade of unprecedented progress, that Dr. Robb is eminently qualified to speak and command our interested attention in relation to the subjects treated in the book before us.

HOWARD A. KELLY.

ASEPTIC SURGICAL TECHNIQUE.

CHAPTER I.

IMPORTANCE TO THE SURGEON OF A BACTERIOLOGICAL TRAINING—SEPSIS AND WOUND-INFECTION—MICRO-ORGANISMS CONCERNED—ASEPSIS—ANTISEPSIS.

THE number of those who do not believe it necessary to observe stringent precautions in operative surgery or who are content to confine themselves to methods which have been proved to be faulty is now, fortunately, very small, and is diminishing every day, so that we may safely say that every prominent surgeon is now working on practically the same lines, being anxious to discover and to carry out any measure which promises to aid the speedy healing of the wounds which he makes and to obviate the dangers of infection.

Among the brilliant results to be obtained from the study of bacteriology, none seems at the present time more important than the establishment on a scientific basis of a thorough technique for surgical operations.

It will obviously be impossible for a surgeon to have any fixed rules by which he may be guided unless he has first obtained a true conception of the meaning of

the terms sepsis, asepsis, and antisepsis, and is determined at all costs to apply his knowledge practically to his every-day work. While the majority of our operators of to-day may theoretically appreciate the dangers of wound-infection, and have read or heard of the various means that are to be taken to prevent it, there are few comparatively who are consistent in the technique which they employ.

It is by no means unusual to hear a surgeon remark that he has performed an "aseptic" operation, or that he always operates "under strictly aseptic precautions," when his technique, as actually observed by one trained in bacteriology, is found to be wofully defective.

The practical scientific application of an aseptic and antiseptic technique can be thoroughly carried out only by observing every, even the most minute, detail, the utility of which has been proved by bacteriological experiment. In order to become familiar with these details, and to be able to appreciate them fully, the surgeon should have had at least an elementary training in bacteriology. If he has not had this training, —and, unfortunately, it has not as yet been possible to secure it at the majority of medical schools,— he must accept and carry out in his work principles which have been laid down by those who have had the opportunity of submitting their methods to the test of bacteriological criticism. Any one who has been trained in a bacteriological laboratory will have exalted ideas of *surgical cleanliness*, and cannot

fail to see the many inconsistencies that occur during the majority of operations. While these inconsistencies may to many appear trifling, in reality they are only too often responsible for the introduction of infectious material into the wound. One would think that an operator, after taking every precaution to render his hands surgically clean, would avoid bringing them in contact subsequently with objects which have not been previously sterilized, and yet it is by no means uncommon to see those who are regarded as "careful men" touching with their hands the face or hair, or permitting them to come in contact with some non-sterile article—such, for example, as a blanket which protects the patient—just prior to or during an operation, and proceeding with their work without thoroughly cleansing them again. If such errors in technique be committed by the operator himself, he can scarcely expect his assistants and nurses to exercise proper precautions.

I remember seeing a surgeon leave the operating-table, while performing an abdominal section, to pick up an unsterilized instrument which he wished to bend at a certain angle and employ in order better to expose the parts. In doing this he used as a support a table and a chair that happened to be near at hand, but which were unsterilized. After having bent the instrument to the desired shape, the surgeon proceeded to employ it immediately without making any attempt to sterilize either it or his hands. I have also seen a nurse, who was assisting with the handling of the

sponges at an abdominal section, take her handkerchief from her pocket, wipe her nose with it, and at once continue with her duty of passing the sponges to the assistant surgeon. On another occasion I saw a surgeon open an abdomen, and after himself examining the structures of the pelvic cavity, invite two professional brethren who were looking on to do the same; and they were actually permitted to introduce their hands into the wound after having simply washed them for a minute or two with soap and water in a soiled basin. At another time an assistant, after drawing a ligature between his teeth, proceeded to thread the needle with it for the surgeon to use in the abdominal wound. Some surgeons have even been guilty of holding the scalpel between the teeth in the course of an operation.

It would hardly be necessary to mention such glaring instances of faulty technique were it not for the fact that errors as bad as these have been observed in men who are considered leaders, and to whose lot it falls to instruct others in surgery. While the surgical judgment and skill of such men may be undoubted, the technique which they employ is dangerous and pernicious. Even after we have become thoroughly imbued with the importance of aseptic work, and have made the most careful preparations before our operations, the technique will never be perfect unless we have schooled ourselves to provide against the unforeseen dangers which are constantly turning up in the operating-room. Every operator of experience, no

matter how conscientious and careful, has met with fatal cases in his practice due to faulty methods, and has had inflammation with pus-formation at or near the site of the wound which he has made.

He who is thoroughly conversant with the conditions which underlie suppuration in wounds and septic processes generally, knows only too well how many are the loop-holes for infection, and to him it seems really remarkable that such cases do not occur more frequently. It is not improbable, especially in conditions of lowered resistance where the cells and tissue fluids of the body do not exercise their normal germicidal power, or do so only in a feeble way, that infection may occur, even though all possible precautions have been taken by the surgeon and his assistants. Experiments have shown that no method has yet been discovered by which the skin can be rendered absolutely sterile, and that the cutaneous glands contain, even after the most careful disinfection of the surface, micro-organisms which in a proper "soil" are capable of giving rise to inflammation and suppuration. Though it may be true, as has been contended by good men, that every wound made by the surgeon contains micro-organisms, we may assume that under ordinary circumstances the resisting powers of the patient will be sufficient to prevent their growth and development. Experience, however, has taught us that there are several kinds of bacteria which under certain conditions possess such virulence, that when introduced into the tissues even of a perfectly healthy

individual they are capable of setting up violent local or general infections. And it is only right that every surgeon shall do everything in his power to prevent the ingress of such bacteria. While admitting that an infection following an operation must, with our present knowledge, be sometimes attributed to a lowered systemic resistance and to no fault on the part of the operator or his assistants, it must be understood that this is a very rare occurrence, and that in nearly every septic case a rigid analysis of the technique employed will bring to light some sin of omission or of commission to account for it. I believe that a perfect technique can ultimately be attained by submitting every step to the test of bacteriological examination, and the surgeon who works on these lines will, *cæteris paribus*, undoubtedly obtain the best results in his own operations, and, what is perhaps just as important, he will be able by his teaching and example to inculcate in others principles by the adoption of which much loss of life may be prevented.

That some surgeons do not seem to pay much attention to a careful technique and yet obtain good results is no sound argument against the carrying out of thoroughly scientific procedures. As a matter of fact, a careful investigation of their results and those of their followers compared with those of aseptic surgeons and their students will, if a sufficient number of parallel cases be taken, certainly show the inferiority of the older methods. Statistics

showing uniformly good results from operations in which no precautions were taken will usually be found to be based on too limited a number of cases to be of much value.

The term *sepsis*, or *septic infection*, includes nearly all of the surgical infections, general or local, resulting from bacterial invasion. The symptoms are due, as a rule, not so much to the direct effect of the bacteria themselves as to the action of their chemical products. When the bacteria have gained entrance into the general circulation and have multiplied there (and several varieties are capable of doing this), we have a general blood-infection which often proves fatal. With or without extensive multiplication of the micro-organisms in the blood, the system may be overwhelmed with the bacterial poisons. This condition is called *acute septicæmia*. Localization of pyogenic bacteria in the organs, especially when they have been transported there by infectious emboli, gives rise to multiple abscess-formation. This condition is called *pyæmia*. These terms are, of course, only relative, and it is customary to speak of infections in which the two conditions are combined as cases of *septico-pyæmia*.

Under the head of *local infections* we at the present day group together all those so-called "accidents" which befall wounds: suppuration, traumatic fever, hospital gangrene, wound-diphtheria, and erysipelas. All of these, though met with much less often than

of old, are still occasionally seen. The rarity of their occurrence is to be attributed to the improvement in operative technique and the less frequent infection of wounds. The phenomena appearing after the absorption into the general circulation of the products resulting from the local growth of micro-organisms, especially putrefactive forms, have been included under the term *sapræmia* or *toxæmia*, but it is not possible to make any sharp distinction between sapræmia and septicæmia. The importance of recognizing clearly the distinction between a purely local infection and a general infection of the blood and organs with bacteria will be easily understood. In the former case the symptoms produced are in direct proportion to the amount of poison absorbed, and if this absorption has not been too great, they will all disappear with the subsidence of the local infection. In a general infection, on the other hand, fresh poison is being constantly produced by the bacteria distributed everywhere through the body, so that local therapeutic measures can then be of no avail.

General septicæmia, or pyæmia, may be set up by almost any of the micro-organisms which have pyogenic properties,—*i.e.*, which are capable of giving rise to local suppuration. The organisms most frequently met with in surgical experience are: the *staphylococcus pyogenes aureus*, the *streptococcus pyogenes*, and the *bacterium coli commune.* Less frequently we have to deal with the *staphylococcus epidermidis albus*, the *staphylococcus pyogenes albus*, the *staphylococcus pyogenes citreus*, the

gonococcus of Neisser, the *bacillus of green pus* (bacillus pyocyaneus), the *bacillus aërogenes capsulatus*, and the *micrococcus lanceolatus* (diplococcus pneumoniæ).

It will be well, perhaps, to describe briefly the principal micro-organisms which concern us in our work, and especially the *pyogenic* bacteria. The forms chiefly concerned in suppurative processes are cocci. Of these the staphylococcus, of which several varieties have been isolated, distinguished by differences both in their chromogenic properties and in their pathogenic power, has been found more frequently than any other associated with acute phlegmons.

The *staphylococcus pyogenes aureus* (Ogston, Rosenbach, *et al.*), or *golden staphylococcus*, is the most important form for the surgeon, and is more common than any other. It is widely distributed in nature, its presence having been repeatedly demonstrated upon the skin of healthy persons, in the secretions of the mouth, beneath the finger-nails, in the air, especially in that of hospital wards, in the water, and elsewhere.

It can thus be easily understood how readily it can come in contact with the field of operation. The cocci grow in grape-like bunches, but in the tissues are also seen in pairs or in groups of four. Plate I., Fig. 1. They stain well in the ordinary aniline dyes, and also by the method of Gram.

The staphylococcus aureus grows well on all the culture media of the laboratory, and forms, especially when allowed to grow slowly with free access of air, large golden-yellow masses.

Its pathogenic power is variable, some varieties being much more virulent than others. Its pyogenic properties for human beings have been clearly proved by the experiments of Garré, who rubbed into the uninjured skin of his left forearm a pure culture of this organism. Four days afterwards a large carbuncle, which was surrounded by isolated furuncles, appeared at the site of the inoculation. The inflammation thus established ran the usual course, and it was only after several weeks that the skin healed over completely. Seventeen scars remained as a lasting proof of the success of the experiment.

When cultures of this coccus are injected into the vein of a rabbit's ear, the animal dies after a certain period of time (which varies according to the virulence of the particular culture used), with symptoms of acute septicæmia, and at the autopsy necroses or small abscesses are found in the various organs.

In human beings this organism has been isolated from suppurating foci of all kinds and in all situations. It is the most frequent cause of superficial and deep abscesses as well as of acute osteomyelitis, and has often been recognized as the infectious agent in acute ulcerative endocarditis and general septicæmia following operations or childbirth.

The *staphylococcus pyogenes albus*, while resembling the aureus in form, can be distinguished from it in that it grows as a white coating on the culture media, and moreover is possessed of less virulence. It has in some instances been found as the only micro-organism

present in acute abscesses, but, as a rule, it is associated with other pyogenic cocci, most frequently with the staphylococcus pyogenes aureus.

The *staphylococcus epidermidis albus* is so called because it is almost always present, even under normal conditions, in the human skin. According to Welch, it is often found in parts of the epidermis deeper than can be reached by any known method of cutaneous disinfection without injuring the patient, and he therefore regards it as a nearly constant inhabitant of the epidermis. This coccus resembles very closely the staphylococcus pyogenes albus, and is distinguished from it only by minor cultural differences and by its lower virulence. It has frequently been found in wounds, the healing of which did not appear to be at all delayed; but experiments have proved that it sometimes causes suppuration along the line of the stitches and in the track of a drainage-tube. In a series of forty-five laparotomy wounds examined by Dr. Ghriskey and myself, where every aseptic precaution had been observed, bacteria were found in thirty-one, or sixty-nine per cent. of the whole; in only fourteen were the results of the cultures negative. In nineteen cases we found the staphylococcus epidermidis albus, in five the staphylococcus pyogenes aureus, in six the bacterium coli commune, and in three only the streptococcus pyogenes.

Cultures made also in a large number of cases from the hands and from the surface of the abdomen showed

that, even after the application of the different methods recommended for surface disinfection, the staphylococcus epidermidis albus still remained, and that, too, in such a condition as to be capable of developing on the ordinary media.

The *staphylococcus pyogenes citreus* (Passet) is characterized by its lemon-yellow growth on agar-agar. It has been found alone in abscesses, and must be looked upon as a pyogenic micro-organism, although it occurs much more rarely than any of the other forms.

The *streptococcus pyogenes* grows in chains consisting of from four to ten or more cocci, each individual coccus being somewhat larger than those seen in cultures of the staphylococcus. Plate I., Fig. 2. This organism stains well by all the ordinary methods. In culture media it grows very differently from the staphylococcus, forming, as a rule, minute pin-point colonies. The streptococcus is one of the most important micro-organisms with which the surgeon has to deal. It has long been known that erysipelatous inflammations are due to the so-called *streptococcus erysipelatosus;* it is doubtful, however, whether this coccus can be distinguished from the ordinary streptococcus pyogenes. In fact, the differentiation of streptococci into distinct species or varieties has thus far met with little success. The streptococcus is found sometimes in acute abscesses, but not so frequently as the staphylococcus pyogenes aureus, with which it is often associated in acute suppurative processes.

External inflammations due to the streptococcus are characterized especially by their spreading character and erysipelatous redness. The streptococcus pyogenes is one of the most frequent causes of post-operative peritonitis. It has further been proved to be the etiological factor in many cases of ulcerative endocarditis as well as of acute septicæmia in human beings, and it is a well-known fact that the pseudomembranous anginas complicating scarlet fever and measles are, as a rule, due to this organism. It has been found in some forms of acute broncho-pneumonia, sometimes in acute pleurisy and empyema, and occasionally in acute osteomyelitis. Comparatively recent researches have shown an interesting relation to exist between the streptococcus pyogenes and the different forms of puerperal infection. Döderlein has shown that in the pathological secretions from the vagina, immense numbers of organisms, and generally streptococci, are present. His work was based upon the study of the vaginal secretions from nearly two hundred women, about one-half of which were found to be abnormal; in ten per cent. of the pathological secretions he was able to demonstrate the presence of the streptococcus pyogenes; inoculation experiments proved that in at least fifty per cent. of these the organism was pathogenic for animals.

It is not difficult, then, to understand how after labor, when the parts are wounded, organisms can enter the circulation and give rise to a general infection, the infectious agent being not infrequently

the streptococcus pyogenes. Clivio and Monti have demonstrated the presence of streptococci in five cases of puerperal inflammation of the peritoneum. Czerniewski found the same organism in the lochia of thirty-three out of eighty-one women suffering from puerperal fever, while in those of fifty-seven healthy women he was able to find it only once. In ten fatal cases he demonstrated its presence in the organs of the body after death. Such observations as these, and many more might be cited, are sufficient to impress upon us the importance of preventing the access of the streptococcus to open wounds. The organism is of very wide distribution, and it is only strange that more patients in surgical and obstetrical practice do not become infected by it. It may be that in many cases, having led a saprophytic existence, it has lost some of its virulence, and is not capable of setting up pathological processes unless it happens to enter a soil particularly suited for its development. Any one who has examined a drop of the fluid exudate from the abdominal cavity in a case of streptococcus peritonitis, and has seen the myriads of cocci present in a single microscopic field, will appreciate somewhat the developmental power of this organism.

From what has been said, the danger of going from a case of erysipelas or of streptococcus phlegmon to a surgical operation or an obstetrical case will be sufficiently evident. Even with every antiseptic precaution more or less danger will be incurred, and one should never take the risk unless it is absolutely

unavoidable. To go to such a case without thorough disinfection would be criminal.

The *micrococcus gonorrhœæ*, or *gonococcus*, was discovered by Neisser in 1879. It is found in the gonorrhœal discharge and in the secretions from the eyes in cases of gonorrhœal ophthalmia. According to some it is always present in the joints in gonorrhœal rheumatism, and it has been isolated from the muscular structures of the heart in cases of myocarditis following gonorrhœa. It is usually to be seen lying within the pus-cells or attached to the surface of the epithelial cells. (Plate I., Fig. 3.) Its specific character has been proved by inoculation into man. It is extremely difficult to grow outside of the body and will not develop at all on the ordinary culture media. A mixture of human blood-serum and agar-agar, or hydrocele-agar, gives excellent results.

Very considerable pathogenic importance has been attributed to this organism, and many gynæcologists are ready to assert that nearly all inflammations of the tubes and ovaries in women are due to its agency. That it does play an important part in the etiology of these affections there can be but little doubt, but whether such an extreme opinion is justifiable remains still uncertain. The clinical history of the patient is occasionally of some assistance, but in the vast majority of cases it is difficult to determine positively whether a pelvic abscess has or has not been preceded by an attack of gonorrhœa.

The *micrococcus lanceolatus* is also known as the

diplococcus pneumoniæ and as the *pneumococcus.* It was discovered by Sternberg, and also independently by Pasteur. It has been studied thoroughly by Fraenkel, Weichselbaum, Welch, and others.

It is an oval or lancet-shaped encapsulated diplococcus which often grows out into short chains, and on that account it was called by Gamaléia the *streptococcus lanceolatus.* Plate I., Fig. 4. It is present normally, either with or without virulence, in the saliva of nearly all human beings, and is the cause of the acute septicæmia (sputum septicæmia) which frequently results in rabbits from the inoculation into them of small quantities of human sputum. It is the causative factor in acute lobar pneumonia and also in many cases of acute broncho-pneumonia, and has been recognized as having given rise to many of the acute inflammations of the serous membranes of the body, —pleuritis, pericarditis, peritonitis, endocarditis, and meningitis. It is now known to be a definite pus-producer, and has been found more than once in acute abscesses, in empyema, in suppurative otitis media, in quinsy, and in suppurative polyarthritis. It is a rapidly-growing micro-organism, but is rather difficult to cultivate outside the body; it easily succumbs under adverse circumstances, and is extremely variable in its virulence.

The *bacillus coli communis*, or *bacterium coli commune*, is constantly present in the fæces of man and of the higher animals. It is a bacillus about one and four-tenths micro-millimetres in thickness and two or three

micro-millimetres in length. Plate I., Fig. 5. It is pathogenic for mice, rabbits, and guinea-pigs, and recently has been proved to be of some importance as an etiological factor in many of the inflammatory processes which occur in human beings. It appears to be the cause more often than any other organism of acute suppurative peritonitis, especially where there has been any communication between the lumen of the gastro-intestinal canal and the peritoneal cavity.* It has also been found in localized abscesses, in suppurative infections of the liver and gall-bladder, in acute hemorrhagic pancreatitis, in cystitis, in pyelitis, and in other conditions. It is interesting to note that in the infections due to this organism and to the micrococcus lanceolatus we have to deal with pathological lesions resulting from the action of bacteria which we normally carry about with us in the exposed cavities of our bodies.

The *bacillus pyocyaneus* was first isolated in pure cultures by Gessard, in 1882, from pus having a green or

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* In an article dealing with micro-organisms concerned in perforation-peritonitis, Barbacci has endeavored to show that the bacillus coli communis, while always present in the exudate, is not the exciter of the inflammation. He believes that other bacteria, which do not grow from cultures made at the autopsies, but which can be observed in cover-slip preparations, are responsible for the setting up of the inflammation. Moreover, Welch pointed out the frequency with which the streptococcus is present in such cases associated with the bacillus coli communis. He adds that the colon bacillus grows so rapidly and abundantly that the minute colonies of the more important streptococci are often overshadowed, and thus may escape observation.

blue color. Plate I., Fig. 6. The organism is widely distributed, and "epidemics of blue pus" are not infrequently seen in hospitals. For some time it was thought not to possess any pathogenic power, but was believed to be simply a concomitant of the pyogenic bacteria. It is generally conceded now, however, that this micro-organism is pyogenic as well as chromogenic in its action, and it has been found to be capable of setting up a general infection in rabbits. Comparatively recently it has been demonstrated that general infection with the bacillus pyocyaneus sometimes occurs in human beings.

The *bacillus tetani* is an anaërobic bacillus discovered by Nicolaier, and first isolated in pure culture by Kitasato. Plate I., Fig. 7. Its natural habitat is the soil. It is commonly present in the fæces of herbivorous animals. The organism is not a pus-producer, and does not become distributed over the body, but develops *in loco*, and it is to the absorption of its toxines into the general system that the symptoms of the disease are due. Fortunately, tetanus is now a comparatively rare complication in surgery.

The *bacillus tuberculosis* does not belong to the group of pyogenic organisms, and only rarely has to be considered in the infection of wounds. Plate I., Fig. 8. As it is concerned, however, in a certain proportion of cases of peritonitis and in some diseases of the genitalia, we have thought it advisable to mention it here. The properties of this bacillus are so well known that we need not describe its history or its general charac-

teristics. It may reach the peritoneum through the blood-current, from the intestines, or through the lymphatic channels from above. In the genitalia the organisms are deposited in the tissues, as a rule, from the blood-current, but it is believed that they may sometimes enter from below,—*e.g.*, by direct contagion from coition.

The *bacillus aërogenes capsulatus*, discovered by Welch and Nuttall, must be mentioned here, as it is occasionally met with in gynæcological and other surgical cases. This gas-producing bacillus has been proved to be responsible for the diffuse septic phlegmonous processes (acute spreading gangrene) so often associated with the production of gas in the tissues. (E. Fraenkel.) It is not a pus-producer in itself, but sometimes occurs along with the ordinary pyogenic bacteria, in which cases there results a mixed infection. It is capable, however, alone of causing spreading gangrene, an extremely dangerous condition, and one which nearly always terminates fatally. Ernst has described a case of fatal septic endometritis following abortion, in which at the autopsy the walls of the uterus were found to be gangrenous and contained bubbles of gas; there were necrotic nodules surrounding cavities filled with gas which were scattered throughout the liver and heart muscle; large numbers of these bacilli existed wherever the presence of gas was demonstrable. Another case of general infection with the bacillus aërogenes capsulatus following abortion, associated with general subcutaneous emphysema

and accumulations of gas in the blood-vessels all over the body, was fully reported in this country in 1894 (Steward, Baldwin, and Graham), and the organism is now recognized as being of considerable pathogenic importance. In order to isolate this bacillus anaërobic methods have to be employed. It varies in length from seven to nine micro-millimetres, is encapsulated, non-motile, and sometimes forms spores. Pelvic abscesses are sometimes found which contain gas, and in such cases the possibility of the presence of this bacillus should always be taken into consideration.

When, after an abdominal section, the patient has died without having exhibited the characteristic symptoms of septicæmia, the death has not usually been attributed to septic infection, but rather has been supposed to be due to "heart-failure," shock, pneumonia, suppression of the urine, or some other more or less satisfactory cause. But when a patient dies even less than twelve hours after an operation we cannot positively exclude sepsis as the cause of death until the fact has been proved by an autopsy made by a competent pathologist and bacteriologist.

Autopsies are on record at which none of the local lesions which attend septic inflammation were demonstrable to the naked eye. The examination of cover-slips, however, made from a small amount of fluid in the pelvic cavity, showed that organisms were present in large numbers, and tubes of nutrient agar-agar inoculated with the same fluid gave the characteristic growths.

Experiments have shown that the poisoning resulting from a peritoneal infection is sometimes so intense as to cause death before the appearance of any marked local reaction in the peritoneum. In the fatal cases in which it has been impossible to secure a complete autopsy, even where during life the ordinary symptoms of such a condition were absent, we have not the right to state positively that death was not due to septic infection.

It is undoubtedly more comforting to the operator to attribute a fatal result to any cause other than this, since he is naturally unwilling to think that his technique has been faulty. Those surgeons who are best able to judge are perhaps most ready to admit the possibility of infection of the wound through some slip during the operation, since it is they who realize the manifold ways in which such an accident might occur.

In practising *asepsis* we aim at bringing about that condition in which there is complete absence of septic material,—a condition which, of course, can be insured only by excluding all pathogenic micro-organisms from the site of operation.

By this we do not mean to say that in the most complete asepsis to which we attain there is always a sterile wound; on the contrary, as we have already stated, it is probable that most fresh wounds contain a certain number of organisms, but these are either non-virulent or are present in too small numbers to give rise to the phenomena of sepsis.

The maintenance of an aseptic condition is certainly one of the most important points to be aimed at in formulating a technique of operative surgery. It is true that an ideal technique which will be aseptic from a bacteriological stand-point, and which will protect our wounds so as to prevent the ingress of even a single bacterium, is scarcely ever possible, at least at the present day; but those who control their technique by bacteriological experiments, and strive in every way to approach as nearly as possible such an ideal, constantly aiming at perfect cleanliness in their work, will undoubtedly obtain better results than those who have no such standard.

In practising *antisepsis* we employ the various means which have been devised for destroying bacteria or for so inhibiting them in their action as to render them incapable of giving rise to infection. The agents which are employed to bring about this condition are known as antiseptics and disinfectants.

Strictly speaking, antiseptics must be classed separately from disinfectants, the latter term applying only to those agents which kill pathogenic or putrefactive organisms, and which may consequently be termed true germicides, the former to the agents which arrest putrefaction or fermentation, but do not necessarily destroy the micro-organisms. A deodorant does away with bad odors, and does not necessarily have either disinfectant or antiseptic powers.

While the bacteriologists have shown us that infec-

tion rarely takes place from the air, they have also demonstrated that it is most frequently brought about by contact. We can thus readily understand the comparative uselessness of the carbolic spray, and the importance of preventing the introduction of bacteria on the instruments or the hands of the operator and his assistants.

The association of laboratory with operative clinical experience must continue; we have learned much, but there is a promise of still greater progress to be reached in this way. While deprecating the adoption of methods based solely upon laboratory experiments, experience having too often shown the inexpediency of such a procedure, I would insist most strongly upon the necessity of the harmonious working together of the surgeon and clinician with the bacteriologist, believing that each and all will in this way gain new facts and new points of view.

But in our enthusiasm for asepsis and aseptic methods we must not by any means lose sight of the importance of a perfected mechanical technique.

Besides depending upon the presence or absence of the seed,—the bacteria,—the question of infection or immunity is influenced to a great extent by the condition of the soil,—the tissues and fluids of the individual. Our more modern knowledge of wounds and wound-infection should by no means tend to make us belittle the skill of the surgeon, and at the same time it should stimulate him to increase his operative precision.

Linear incisions, the avoidance of any rough handling of the tissues and of the use of irritating fluids in the wounds, the filling of dead spaces with substances having their origin in the body (serum, moist blood-clot, known to have definite germicidal power), the abbreviation of the time required for operations, the maintenance of hygienic surroundings, and the adoption of every means for strengthening the vital resistance of the patient—all contribute largely to a surgeon's success.

CHAPTER II.

PRINCIPLES OF STERILIZATION—DRY AND MOIST HEAT—FRACTIONAL STERILIZATION—CHEMICAL DISINFECTION.

By the term *sterilization*, as employed in connection with surgical technique, we properly mean a process which brings about the absolute and complete destruction of bacteria.

The most reliable way of destroying infectious material is by the use of the actual flame; but this, of course, can be applied in only a few instances, and, fortunately, we have other agents from which to make our choice: 1. Heat, (*a*) dry and (*b*) moist. 2. Chemical disinfectants.

Any or all of these methods may be supplemented by mechanical means,—washing, rubbing, brushing, scraping, and the like.

One may well allow one's self to be guided by the modes of procedure adopted in the bacteriological laboratories, for there the best methods of sterilization have been elaborated, inasmuch as the technique employed in the sterilization of culture media, to be of any use at all, must obviously be devoid of flaws. As we shall see, however, the laboratory methods are to be used only as a guide, for many ingenious modifications of them have to be introduced in order to render possible their practical application to operative sur-

gery. As a rule, those micro-organisms which do not form spores (vegetative bacteria) are killed at a comparatively low temperature (58° to 65° C., 136° to 150° F.), while the destruction of spore-containing bacilli requires higher temperatures and stronger chemical solutions. Fortunately, the ordinary pyogenic cocci do not, so far as we know, form spores, and so are easily destroyed, in this way differing from the tetanus-bacillus and the tubercle-bacillus, which belong to the second category.

It goes without saying that, before any further attempt is made to proceed to the sterilization of an object, all extraneous material is as far as possible to be removed by the ordinary mechanical methods. In my remarks upon the different methods of sterilization to be employed, those which may still be considered to be *sub judice* will be disregarded, and only those procedures will be described which have proved themselves by their effectiveness and the reasonableness of their cost to be suitable for recommendation to the practical surgeon.

Sterilization by fire—i.e., by means of the actual flame—is used by the surgeon only on very rare occasions, except for doing away with worthless and dangerous objects, such as soiled dressings, and need not be discussed at length here.

For the carrying out of *sterilization by means of dry heat* a "hot-air sterilizer" is required. This consists of an oven made of sheet-iron with double walls, and fitted with shelves, on which the articles to be sterilized

are placed. (Fig. 1.) The heat is supplied by a rose or tulip gas-burner beneath, and the temperature is registered by a thermometer which passes through the roof of the oven. To kill the ordinary vegetative (non-spore-forming) bacteria, exposure to dry heat at a temperature of 100° C. (212° F.) for one hour and a half is sufficient; but where spores exist a temperature of 140° C. (284° F.) for three hours is necessary. Unfortunately, the process of sterilization by means of dry heat destroys many substances of vegetable or animal origin, and has now, even in the disinfection of metal instruments, been supplanted by more convenient and speedy methods. Dry heat does not permeate the substance to be sterilized nearly so thoroughly as steam heat, and is in consequence much more difficult to control. It still, however, finds an important application in the sterilization of glassware.

FIG. 1.

Hot-air sterilizer.

In the *sterilization by means of moist heat*, one of the quickest agents which we possess is *boiling water*.

The ordinary pyogenic cocci and other vegetative

bacteria are killed by it in from one to five seconds, while anthrax spores succumb in about two minutes; and while it is true that there are spores which are much more resistant, these are not pathogenic for human beings, so that we may safely say that exposure to the action of briskly boiling water for from fifteen to thirty minutes will almost certainly insure complete disinfection.

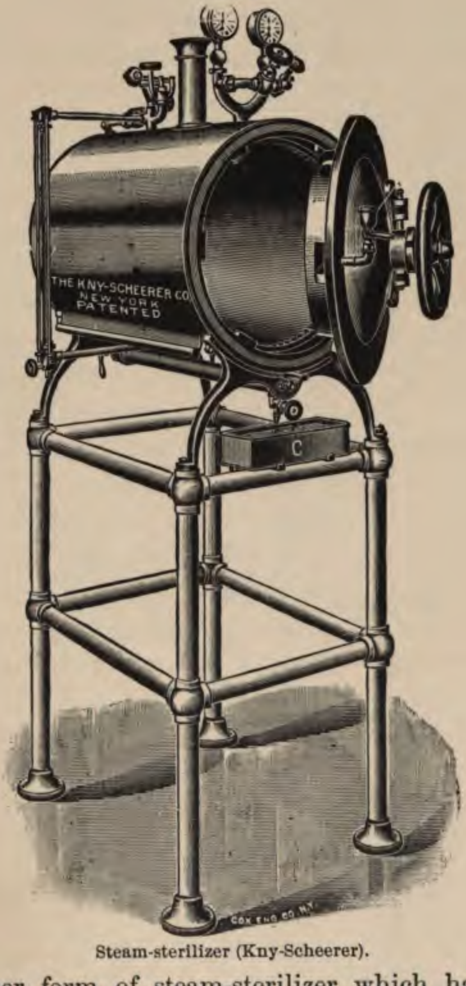
FIG. 2.

Steam-sterilizer (Arnold).

Sterilization by steam is another simple and practical method. To insure success an apparatus must be used in which all the air is expelled from the chamber by the steam and an even temperature of 100° C. (212° F.) can be maintained throughout.

Several kinds of steam-sterilizers have been recommended. One of the cheapest and most convenient is the copper sterilizer of Arnold, made by Wilmot Castle & Co., Rochester, New York. (Fig. 2.) This is especially useful for sterilizing bandages and gauze dressings, and is so generally known that it need not be described here.

FIG. 3.

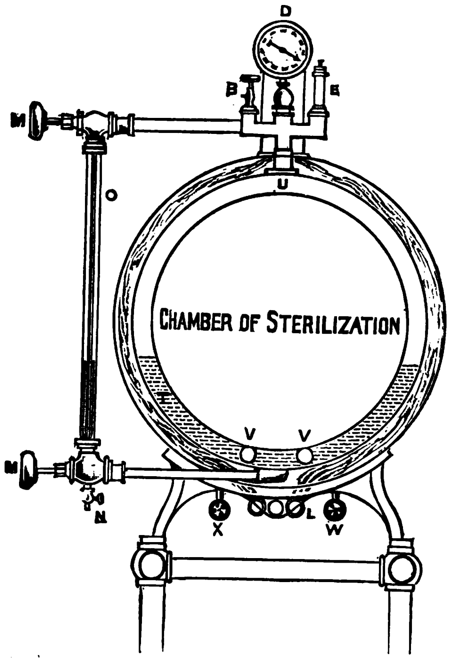


Steam-sterilizer (Kny-Scheerer).

Another form of steam-sterilizer which has given very satisfactory results is represented in Fig. 3. In

hospitals or other places where large quantities of clothing and other materials have to be sterilized at one time large steam disinfectors must be set up.

FIG. 4.



Steam-sterilizer (in section).

For quick and thorough disinfection steam under pressure is employed. (Fig. 4.)

One of the most ingenious methods of insuring complete disinfection is that known as *fractional* or *discontinuous sterilization.* If a fluid be kept at a temperature of 100° C. (212° F.) in a steam-sterilizer for twenty minutes, all vegetative forms of bacteria will be de-

stroyed. If this fluid then be kept for twenty-four hours at the ordinary room or body temperature, any spores which have escaped destruction (certain spores are known to resist a two hours' exposure to streaming steam) at the first heating will have grown out into vegetative forms, and can then be killed by a similar exposure on the second day. If the process be repeated for a third time, one can be reasonably sure of having secured a completely sterile fluid. Tyndall, Pasteur, and others have shown that complete sterilization is practicable with the use of much lower temperatures (60° C., or 140° F.), if the process is repeated on three or four successive days.

While, as has been said, steam sterilization, where applicable, is a most reliable and satisfactory method, we can see at once that its universal employment is out of the question. For example, to use steam heat for the disinfection of the hands of the operator and of his assistants is impossible, neither can it be employed for the body of the patient to be operated upon. Again, it must not be used in the sterilization of objects made of leather or rubber, as these substances are destroyed by it.

On no subject in surgery have the opinions of men changed so much, perhaps, as upon the value and sphere of usefulness of the "individual antiseptic," and the zeal of imperfect knowledge is responsible for much of the opprobrium which has been thrown by some upon the "antiseptic" treatment of wounds.

The ideal chemical disinfectant will be one that can be readily employed for a variety of purposes, so as to be generally useful in practice; it should be easily soluble in water and inexpensive; it should possess active germicidal powers, and not simply lead to the arrest of the development of bacteria; it should exert a sufficient action within a reasonably short space of time; it should not injure the substances to be disinfected, and should be of such chemical composition that it cannot be easily decomposed or rendered inert by chemical combination with the substances to be disinfected; and, finally, it should not endanger those who handle it, nor possess any very unpleasant odor. A careful study of the properties of the ordinary chemical disinfectants in use will soon convince any impartial observer of the many deficiencies of the best of them when judged by this standard.

Carbolic acid is a powerful antiseptic, but a dangerous one. In fact, there are no antiseptics of much power which can with impunity be poured into a wound. The day has come when we must relegate the use of antiseptics to the period before an operation, and rely during the operation on the maintenance of an aseptic condition. *Antisepsie avant l'opération, asepsie pendant* (Terrillon).

Carbolic acid is a fairly stable body, and has the advantage of being readily soluble in water (up to the strength of five per cent.) with the aid of heat. If the solutions are made with cold water, it is advisable to add an amount of alcohol or glycerin equal to that

of the acid employed. Carbolic acid, besides being a disinfectant, is also a deodorizer and local anæsthetic. It is well to keep a two-and-a-half-per-cent. and a five-per-cent. solution always on hand. The dressing recommended by Keith for cœliotomy wounds, now no longer employed, consisted of one part of pure carbolic acid mixed with fifteen parts of glycerin. Solutions of carbolic acid in oil have no antiseptic value.

Corrosive sublimate (mercuric chloride, $HgCl_2$) for a long time has occupied a prominent place in the list of disinfecting agents, but the deductions drawn from the experiments at first made with it have been proved to be incorrect. Koch asserted that a single application of it for but a few minutes, without any previous preparation of the objects to be disinfected, guaranteed an absolute disinfection even in the presence of the most resistant organisms. Gärtner and Flügge, Behring, Tarnier, and Vignal thought they had shown that the yellow staphylococci were killed in from a few seconds to as many minutes by exposure to the action of a one to one-thousand solution of corrosive sublimate; but after Geppert had drawn attention to the fallacies of these early experiments, our views on the value of bichloride of mercury as a disinfectant underwent a material change. Geppert showed that the principal source of error lay in the failure to guard against carrying over, together with the bacteria which had been exposed to its action, enough of the sublimate to prevent the growth and development of the organisms in the nutrient media to which they were trans-

ferred for the purpose of determining whether or not they had been killed. He found, by precipitating the mercury with a solution of ammonium sulphide and thus converting it into the insoluble and inert sulphide, not only that the pyogenic bacteria had not been killed, but that they often still possessed the power of setting up disease in animals.

In order to see how far these objections were applicable to surgical disinfection, Abbott, working in Professor Welch's laboratory, repeated the experiments with sublimate, with particular reference to the pyogenic organisms, observing most carefully the precautions indicated by Geppert. He found that even under the most favorable conditions a given amount of sublimate had the property of rendering inert only a given number of individual organisms, the process being a definite chemical one, consisting in a combination of the sublimate with the protoplasm of the bacterial cell. He also found that the disinfecting power of the sublimate is profoundly influenced by the proportion of albuminous material present in the medium containing the bacteria, and that while certain organisms (yellow staphylococci) after exposure to sublimate may undergo a temporary alteration, these effects may be made to disappear by successive cultivations in normal media.

The extreme toxicity of sublimate is so well known and so generally appreciated that it would scarcely be necessary to mention it were it not that many undoubted and probably some unsuspected cases of death

from sublimate-poisoning have occurred following the irrigation of wounds with too strong solutions of this substance. Besides showing the general toxic effects, the experiments relating to the local injury done to the tissues by chemical disinfectants are full of interest, inasmuch as it has been definitely proved that the local necroses caused by these chemical irritants favor the multiplication of the micro-organisms of suppuration. Thus it has been shown that irrigation of fresh wounds with a solution of bichloride of mercury as weak as one to ten thousand is followed by a distinct line of superficial necrosis, which can easily be demonstrated under the microscope, and it is readily conceivable that solutions even much more dilute may render inert those delicate processes by means of which the cells and tissue fluids exert a germicidal power. The ill effects, then, whether general or local, which may follow from its toxicity, to say nothing of its inefficiency, would seem absolutely to preclude the use of corrosive sublimate for irrigation in the case of fresh wounds. Moreover, it must now, even as an agent for the external disinfection of inanimate objects, rank much lower than formerly. As, however, it is required for certain purposes, it is well to keep a supply on hand. The most convenient strength for a stock solution is five per cent., which can be made by dissolving with the aid of heat fifty grammes (770 grains) of sublimate and the same amount of common salt in one litre (33½ ounces) of distilled water. From this the solutions required for use can be made in a

moment by dilution with a proper amount of water; thus, twenty cubic centimetres ($5\frac{1}{2}$ drachms) of the stock solution with the addition of enough distilled water to make one litre ($33\frac{1}{2}$ ounces) give approximately a one to one-thousand solution. The use of distilled water and the addition of salt are necessary in their preparation, since otherwise, if sublimate solutions are allowed to stand, the mercuric salt is gradually transformed into an inert oxychloride.

Potassium permanganate, in solutions varying in strength from one to one hundred to one to ten, possesses some germicidal power. This is materially enhanced by an after-treatment with *sulphurous* or *oxalic acid*. It has been suggested that its effects are due to a process of oxidation. Reference will be made to the mode of its application when we deal with the disinfection of the skin.

Formalin.—This is a forty per cent. solution of formaldehyde, which was introduced in 1894. It is sometimes used especially for the disinfection of clothing, leather materials, brushes, and books. The materials are exposed to the vapor for twenty-four hours, and afterwards treated with ammonia to remove the disagreeable odor of the formalin. It certainly possesses antiseptic powers, but it is slow in its action. There appears to be no likelihood that it will take a prominent place in surgical technique unless it finds application as a preservative fluid, one part to ten thousand preventing the development of putrefactive bacteria.

Other chemical disinfectants, such as solutions of boric

acid, of naphthol, chloral, and salicylic acid, are of questionable usefulness, and, as will be seen when we treat of the methods advised for practical disinfection, are of extremely little value; they may therefore be dispensed with by the surgeon in his operations. Preparations of cresol, lysol, and other coal-tar derivatives may sometimes be convenient as deodorizers, but are not to be relied upon as disinfectants.

CHAPTER III.

PRACTICAL APPLICATION OF THE PRINCIPLES OF STERILIZATION—OPERATING SUITS—PREPARATION OF THE SURGEON AND HIS ASSISTANTS.

THE principles to be followed by the surgeon in formulating for himself a scientific technique have been already indicated. The necessity of paying attention to the most minute details has been insisted upon, and enough has been said to show that the smallest slip may invalidate the whole procedure. But however well trained and skilful he himself may be, it is easy to understand how dependent an operator is upon those about him for the prevention of technical errors. It is only by choosing assistants who are thoroughly imbued with the strictest ideas of asepsis, who are willing to learn and are enthusiastic in their work, that he can hope to receive much aid from them. And after a surgeon has surrounded himself with desirable and faithful assistants, he will find it advantageous repeatedly to review and drill them in the minor points. Above all, he should, by setting a good example, endeavor to keep everything up to the mark and to establish a system of intelligent routine. Any good work necessarily involves a great deal of drudgery, and in the technique of the newer surgery the lazy man has no place.

A daily bath and special attention to personal hygienic measures are essential to all who work in the operating-room. The tax on the physical powers of those who operate several times a week is by no means light, and it is only with the best care of his personal health that a surgeon, even when naturally strong, will be able to maintain his full physical vigor.

It will be necessary to provide for the operating-room a sufficient number of suits especially adapted for the purpose, and made of some material which can be easily sterilized. For now that we know the dangers of infection by contact, it would seem essential that not only the surgeon but all of his assistants should wear at every operation thoroughly clean sterilized suits. During an operation the sleeve or some other portion of the dress may come in contact with the field of operation, or one of the surgeons may accidentally touch the clothing of one of his fellows, and thus, if the suits are not sterile, pathogenic micro-organisms may readily be introduced into a wound. It is safer and better that all should put on a complete change of costume rather than simply draw on a sterilized coat and pair of trousers over the ordinary clothes, as has been recommended by the German school. The former plan also offers many advantages, for not only are the warm out-door clothes exchanged for thin, cool garments, which are far better suited for the temperature of the operating-room, but the ordinary clothes run no risk of being soiled or of carrying away on them the disagreeable odor of the fumes of

the anæsthetic. Besides this, such suits afford much better protection against infection and are not nearly so cumbersome and awkward to work in as a sheet or rubber apron. They are best made of some white material that can be easily and thoroughly washed. Twilled muslin, costing about thirteen cents per yard, is perhaps the most serviceable for this purpose. The suits should be made to fit comfortably and should be fairly loose, so as not to impede the movements in any way. They can be made in one piece like a bathing-suit, with buttons down the front, and with a belt attached to the waist. The sleeves of the jacket should extend to just above the elbow-joint. (Fig. 5.) It is more usual, however, to have them made in two separate parts, consisting of a shirt (or jacket) and a pair of trousers. The jacket can be made so as to button down either the front or the back, the former arrangement being probably the more convenient. The trousers should not be long enough to allow the bottoms to drag on the floor. To sterilize these suits it is not sufficient to trust to the washing that has been given them in the general laundry, as even after this they could easily contain infectious material from coming in contact with the hands of those employed in ironing and afterwards folding them. In order to do away with this source of danger, it is necessary that they should be thoroughly sterilized before they are worn. This can be done by wrapping them in a towel or by placing them in bags made of butcher's linen, and then exposing them to the streaming steam

of the sterilizer for half an hour. They can then be taken out of the sterilizer and allowed to dry on a clothes-line which has either been sterilized or which is covered with sterilized cloths or towels. Or, better

FIG. 5.

Suits worn by operator and nurse.

still, this step can be dispensed with by using the autoclave, in which they are sterilized and then left to dry. After they have been thoroughly dried they may be put away in dry sterilized towels or bags until they are required for use. The nurse or assistant who attends to the sterilization of these suits

should, of course, after the process is completed, be careful not to nullify the results in putting them away. Danger can be easily avoided by protecting the hands with rubber gloves which have been soaked in a one to five hundred aqueous solution of bichloride of mercury before being used. The sterilization should be done some time before the suits are required for use, so that they may have time to become thoroughly dry, a process which will generally be found to take three or four hours.

The operator, his assistants, and the nurses should wear white canvas shoes with low tops and with rubber soles. They are clean and noiseless, and by their employment the soiling of the street shoes during an operation is avoided. They can be easily cleaned by washing them off with hot water, and a coating of pipe-clay will give them a very neat appearance.

When putting on the operating suits, care must be taken to allow the hands to come in contact with the clothing as little as possible. All the ordinary clothing should be first removed, then the white shirt and trousers are carefully put on, the shoes being adjusted last of all.

In hospitals there should be a dressing-room adjoining the operating-room. Too much attention cannot be paid to the minor points of personal cleanliness. It is important to keep the head and face scrupulously clean. The hair of the head should not be allowed to grow long, and should be kept as free as possible from dandruff. It has been suggested that the surgeon will

do well to moisten the hair before an operation, since particles of dust might easily fall down from his head into the open wound, and thus, particularly if some inflammatory condition of the scalp were present, might produce a dangerous infection. Sterilized muslin caps or fillets may be worn. If he be willing, the surgeon had best be clean shaven. A heavy beard should never be permitted in close proximity to an open wound. The finger-nails should be kept well trimmed, for a long nail at times does a great deal of injury by scratching and otherwise injuring the tissues. They should not be cleaned with the blade of a knife, as this will wound the matrix. A bit of wood or ivory shaped like a toothpick, or even a match shaved down, will answer very well.

Since Eberth, in 1875, demonstrated the presence of large numbers of bacteria in normal sweat, many experiments have been made in this direction, and as a result our ideas with regard to the surgical disinfection of the skin have been more or less completely overturned. Several different kinds of bacteria have been found upon the surface of the human body, and a whole bacterial flora for this region has been described. Attempts have been made to determine whether or not any particular kind or kinds of bacteria are constantly present there. The results of the European investigators on this point are more or less at variance. Bordoni has even advanced the view that groups of men in every country have a peculiar bacterial flora of their own upon the body surface, and

that the flora varies with the occupation. The experiments made in the Pathological Laboratory of the Johns Hopkins University have been rewarded with the isolation of a form of bacterium which has been found to be almost constant in the skin. This variety is a white staphylococcus, and has been named by Professor Welch the staphylococcus epidermidis albus, to which reference has been made above. (Chapter I.) The significance of these investigations, as bearing upon the disinfection of the hands and forearms of the surgeon and his assistants, can hardly be overestimated, and we cannot but feel that the question of this disinfection has not even now received the consideration which it deserves. The gist of the matter is contained in the following sentences which we have taken from Dr. Welch's article. "Since the institution of bacteriological control as a test of the sufficiency of surgical technique, many methods before believed to be reliable have been proved to be faulty. We are past the days when an ordinary washing of the hands with soap and water followed by a dash of sublimate solution sufficed to put them in a condition to enter a clean wound. Numerous experiments that have been made with a view of ascertaining the best methods of accomplishing the sterilization of the hands show that it is indeed a difficult matter to effect it, and especially to insure the destruction of micro-organisms which lie beneath the finger-nails."

Fürbringer, in an extended series of experiments in

1888, found that a preliminary cleansing with soap and water together with a vigorous use of the brush was even more important than the subsequent employment of a disinfectant solution. His method of disinfecting the hands is as follows: (1) The nails are kept short and clean. (2) The hands are washed and scrubbed thoroughly for one minute with soap and hot water. (3) They are next washed for one minute in alcohol at 80° C. (176° F.), in order to remove all fatty and oily substances. (4) They are then scrubbed for one minute in a warm solution of carbolic acid (two per cent.) or of sublimate (one to five hundred).

I fully concur with Fürbringer's suggestion that the effects of cleansing with soap and brush, the water used being as hot as it can be borne, are of more value than those obtained from the employment of disinfectant solutions. In this mechanical removal of organisms we have therefore an agent of the first importance. This fact the author has demonstrated many times in the following way. Cultures were taken from the hands before the scrubbing was begun and then several times again at different periods of the process, the results showing that the longer we scrub with soap and water the fewer the number of bacteria which are left. Cultures taken after scrubbing for ten minutes always showed a less number of bacteria than those taken after five minutes' work had been done on the hands.

The inefficiency of chemical disinfectants has shown the necessity of bringing about as thorough a removal

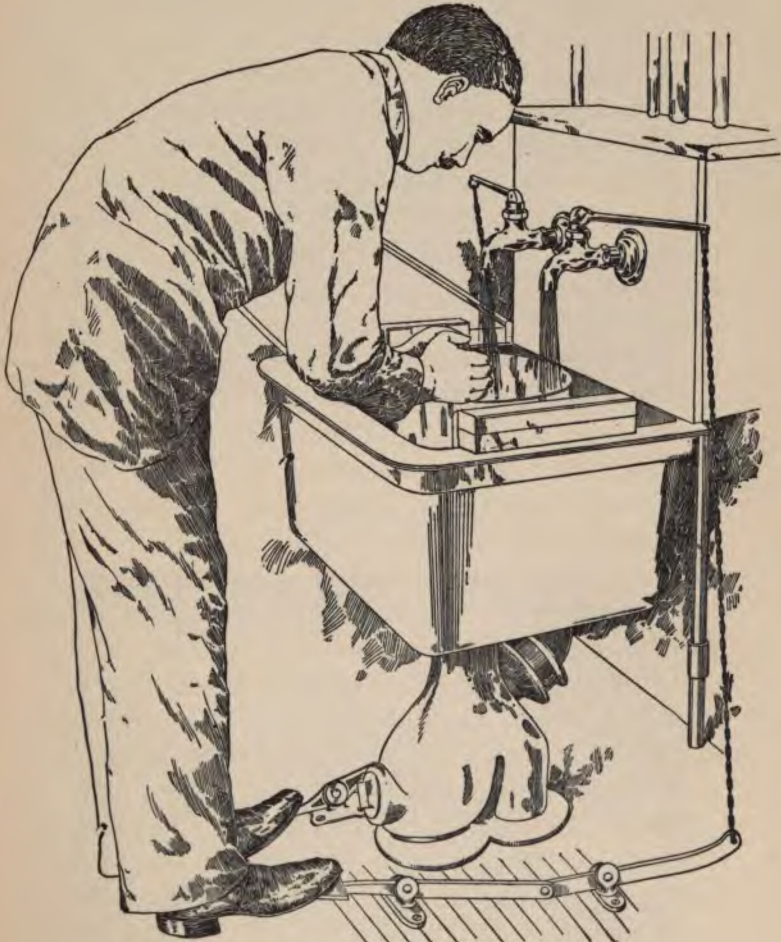
of the bacteria as is possible by the mechanical action of the scrubbing, and of not trusting too much to these uncertain chemical agents, which henceforth must play a subordinate *rôle* in disinfection.

Not only, then, must the operator and his assistants but all those who in any way aid in the handling of the materials that are employed during an operation be very thorough with the cleansing of their hands. A French surgeon has gone so far as to state that in ninety-nine cases out of a hundred, when infection takes place, it occurs during the operation, from the instruments, the hands of the surgeon, the sutures, the sponges, the dressings, or from the patient herself.

Fürbringer's method, when conscientiously carried out, yields fairly good results, but it has been shown that if the mercury is precipitated with ammonium sulphide, and scrapings taken from the skin which has been thus prepared are placed in nutrient media, the presence of numerous living bacteria can still be often demonstrated.

After applying bacteriological tests to the methods usually employed, we have found the following to be the most reliable. The operating-room suit with the short sleeves having been put on, the hands and forearms are scrubbed vigorously for ten minutes by the watch with a stiff brush, previously sterilized by steam, and with green soap, the water used being as hot as can be borne and being changed at least ten times. In order to avoid any possible contamination from the necessity of turning the spigots off and on with the hands,

FIG. 6.



Spigot attachment.

in 1893 I had constructed an arrangement by means of which this can be done equally well with the feet. (Fig. 6.) The excess of soap is washed off in hot water and the hands and forearms are then immersed for two minutes in a warm saturated solution of permanganate of potassium, which should be well rubbed into the skin with the aid of a sterilized swab. (Plate II.) They are next washed in a warm saturated solution of oxalic acid until the stain of the permanganate has completely disappeared. In our clinic saturated solutions of potassium permanganate and oxalic acid in large flasks are sterilized for fifteen minutes in the autoclave. Just before the operation sufficient quantities are warmed and poured into sterilized basins. The hands and forearms are then rinsed off in sterilized water or sterilized salt solution, and finally are immersed in a solution of bichloride of mercury (one to five hundred) for two minutes.

At the risk of repetition, it must be insisted again that after the hands and forearms have been once prepared they must on no account be allowed to come in contact with objects which are not sterile, or the whole work will be undone, since "a chain is no stronger than its weakest link." The smallest slip is fraught with danger to the patient.

Just before beginning the operation the hands and forearms should be well rinsed in sterilized salt solution, to remove any excess of the bichloride. After these procedures have been employed, cultures made from the scrapings underneath and around the nails,

PLATE II

(a) Sterilization of hands with permanganate of potassium.

(b) Washing away permanganate of potassium with oxalic acid solution.

even after precipitation of the mercury, yield almost always negative results.

It is to be remembered that little or nothing certain can be attained unless each step is conscientiously carried out. In fact, if practised in a slipshod manner, an elaborate technique does more harm than good by deceiving us with a sense of security which is unwarranted.

The use of sterilized rubber gloves and armlets undoubtedly affords the best means of preventing contact infection. Although they may at first make the operator feel somewhat clumsy, after a little experience he will find that they will not materially interfere with the delicacy of touch and manipulation. A somewhat extended experience has convinced me of the great advantages to be derived from their use, and I now consider them as essential accessories to an aseptic technique, and as eliminating many dangers.

After the hands and arms have been sterilized, and the rubber gloves and armlets adjusted, a sterilized short-sleeved gown or a short apron, which covers the operator from the shoulders to the thighs, is put on. (See Fig. 5.)

The strict observance of all these details may seem to be a tedious and an almost endless task, but when we consider how important it is to obtain and preserve a condition of surgical cleanliness, we shall not grudge any time or trouble spent upon them, and in a short while all will become an easy matter of routine.

There are many other points connected with this

subject to which we might refer. Thus, should the operator perspire, the moisture should be removed from his face by a nurse with a towel before any drops have been allowed to fall into the wound. Talking should be avoided over the field of operation, as saliva and its accompanying micro-organisms may by some accident gain access to the wound. If he can avoid it, the surgeon should never operate when he is suffering from coryza, or from a catarrh which is accompanied by mucous secretions. The handling of a pocket-handkerchief makes a break in the technique,—a point always to be remembered. It would be impossible to enumerate here all the contingencies which the aseptic surgeon has to meet, and he will have to trust to his common sense to teach him to consistently apply the principles upon which his whole technique is based.

CHAPTER IV.

THE PREPARATION OF PATIENTS FOR OPERATIONS, MAJOR AND MINOR—MEANS EMPLOYED TO OBTAIN AN ASEPTIC FIELD.

It is advisable to have a patient who is to undergo an abdominal section, or, in fact, any operation, under careful observation for some few days, in order that we may get some idea of the condition of the different organs of the body or of any particular idiosyncrasy which she may have, and may be able to follow out any indications by which her general condition may as far as possible be improved and her powers of resistance proportionately increased. In some cases rest in bed for a few days prior to an operation will be of decided advantage.

In ordinary cases the patient should take a daily bath for one or two days prior to the operation. She should also receive a daily vaginal douche of a warm one- to three-per-cent. aqueous solution of carbolic acid. The former will usually be strong enough for abdominal cases, and it is perhaps better not to use the three-per-cent. solution even in all plastic cases, as it not infrequently gives rise to pain. The bowels should be opened daily. This can be accomplished by gentle laxatives,—*e.g.*, the citrate of magnesium, a seidlitz powder, or the compound liquorice powder. Twelve or twenty-four hours before the operation a

good purge is given, and two or three hours before the patient is placed upon the table the rectum should be well emptied by means of a large enema of soap and warm water. If the enema is omitted or not given in such a way as to prove effectual, the bowels are liable to be moved while the patient is on the table, and thus, especially in plastic cases, the progress of the operation may be very much delayed and danger of infection incurred. The doctor should give explicit directions to the nurse with regard to this matter.

Light, nourishing food should be taken, and nothing that is liable to upset the stomach should be allowed. The patient is generally permitted to have any kind of soft food which seems to agree with her during the two or three days preceding the operation, except that in the last twenty-four hours she is restricted to milk or broths made from chicken or mutton, although at times stewed fruits are allowed. As a rule, unless she is very weak and requires stimulants or nourishing broths, she should take nothing by the mouth after midnight. Shortly before the patient is anæsthetized the bladder should be emptied, and if the urine cannot be voided naturally, she should be catheterized.

In urgent cases, such as those of suppurative peritonitis or of extra-uterine pregnancy where rupture has taken place, there is, as a rule, little or no time for any preparation before the anæsthetic is administered. In any case, however, an enema should be given.

The further preparation of the patient for an abdominal section is about as follows. On the night

preceding the operation the abdomen and pubes, after being thoroughly shaved, are scrubbed with soap and water, next with equal parts of alcohol and ether, in order to remove all oily and fatty substances, and finally with a solution of bichloride of mercury (one to one thousand).

The field of operation is now covered with a thin poultice of green soap, which is allowed to remain on for from one to three hours, according to the degree of sensitiveness of the skin. The soap is removed by scrubbing the parts with a brush and hot water, so as to get rid of as much epithelium as possible. A large compress wrung out of a warm bichloride solution (one to one thousand) is then applied to the abdomen and held in place with a bandage.

To summarize, the abdomen may be rendered practically sterile in all cases if the following procedures are adopted.

1. A bath of soap and water and a vaginal douche of a one-per-cent. carbolic acid solution are given daily for three days before the operation.

2. The hair of the abdomen and pubes is shaved on the night preceding the day of the operation.

3. The parts are given a thorough scrubbing with (*a*) soap and water, (*b*) alcohol and ether, (*c*) bichloride of mercury (one to one thousand).

4. A poultice of green soap is applied for from one to three hours.

5. The soap is removed by scrubbing with brush and hot water.

6. A compress of bichloride (one to one thousand) is applied, and is kept on until the patient is brought to the operating-table.

FIG. 7.

Robb's aseptic razor, with case.

The nurse in charge of the case must see that the patient is properly attired before leaving the ward and that every precaution is taken to avoid all danger of her becoming chilled. Over the fresh night-gown a warm wrapper should be drawn. Long stockings which reach well above the knees are desirable for warmth as well as for the avoidance of unnecessary exposure.

After the patient has been anæsthetized and placed upon the operating-table, the compress is removed and the following additional steps are carried out.

1. The field of operation is scrubbed with soap and warm sterile water.

2. It is sponged again with alcohol and ether.

3. In some cases it is washed with solutions of per-

manganate of potassium and oxalic acid, as in the disinfection of the hands, and subsequently irrigated with warm sterile water or salt solution.

4. It is irrigated with one litre of a solution of bichloride of mercury (one to one thousand).

5. It is irrigated with sterilized salt solution to remove any excess of sublimate.

The rules for diet and preliminary preparations for both major and minor operations have been given above. We should aim at as thorough an aseptic technique in plastic work as in abdominal surgery. While, in the majority of instances, faults in technique are not so often associated in these so-called minor cases with disastrous consequences as when the same errors have been committed in abdominal sections, yet there are many instances on record of death from sepsis following upon a simple plastic operation; and could we properly analyze the list of cases in which the fatal outcome has been attributed to pneumonia, to lesions of the kidney or other organs, their number would undoubtedly be much augmented. In not a few obscure cases in which death has followed a plastic gynæcological operation, a thorough autopsy, together with a careful bacteriological examination, have demonstrated that death was due to an infection with pyogenic bacteria. Many of the cases which we have been inclined to regard as cases of acute nephritis are now known to be cases of infection with associated acute lesions of the kidney. I may cite a case here which recently came under my notice, where it was possible

to show beyond doubt that pyogenic micro-organisms had found an entrance at the site of a perineal operation. A woman fifty-eight years of age, six weeks after a perineorrhaphy gradually developed symptoms suggestive of a nephritis. Examination of the urine showed the presence of albumin and of hyaline and granular casts. She gradually grew worse and died a week later in coma. At the autopsy minute abscesses were found in the heart muscle, in the liver, spleen, kidneys, and intestines, and agar-agar Esmarch tubes made from these organs gave in every case a pure culture of the staphylococcus pyogenes aureus. The portal of entrance was found to have been the deep perineal tissues, where, just beneath the line of the wound, small collections of pus were found. Externally, the wound appeared to have healed perfectly.

Death has more than once followed as a result of apparently trivial operations upon the uterus, cervix, and vagina, and this fact should teach us that no operation, however insignificant it may seem, should be lightly undertaken or carried out without due regard for the dangers of infection. As a rule, it is difficult to have the field of operation thoroughly clean and to keep it so during these minor operations. Still, although this is even more difficult to accomplish than in abdominal cases, the attempt must be made.

On the previous evening the parts are carefully shaved and scrubbed with soap and water; they are then washed off with sterilized water, and afterwards with a solution of the bichloride of mercury (one to one thousand).

After the patient has been placed upon the operating-table, the vagina, perineum, and external genitalia are to be thoroughly scrubbed with oleine soap and sterilized water. This should take at least from three to five minutes; a liberal supply of soap should be used, and it should be well rubbed into the skin. In order to cleanse the vagina, a small oblong piece of soap is introduced well into the cavity and the suds rubbed thoroughly into the walls, or a large piece of absorbent cotton, held with a sponge-holder or bullet-forceps, can be used as a swab. Next follows an irrigation with 250 cc. of a ten-per-cent. solution of creolin and finally with warm sterile water. The excess of soap having been washed off with warm sterile water, the external parts are rinsed with a litre of warm (one to one thousand) aqueous solution of bichloride of mercury, and finally with sterilized water or salt solution. If there are large, protruding hemorrhoids and a considerable surface of the rectal mucous membrane is exposed, caution is necessary in using the bichloride of mercury, as it is easily absorbed and may give rise to toxic effects. Under these circumstances it is well to wash out the rectum with a solution of permanganate of potassium (one to one thousand) morning and evening for two days before the operation, while on the morning of the operation soap and water only are employed, and the parts are finally rinsed off with sterilized water. The maintenance of asepsis throughout the operation will be discussed more fully later on.

CHAPTER V.

GYNÆCOLOGICAL INSTRUMENTS—METHODS OF STERILIZATION—INSTRUMENT TRAYS—CARE OF THE INSTRUMENTS AFTER OPERATIONS.

THE more modern principles of treating wounds have led to certain marked modifications in the surgeon's armamentarium, and in no part, perhaps, has the change been so pronounced as in the kind of instruments used in operative work. The day of instruments with elaborately carved wooden and ivory handles is past, and complicated trocars and tubular needles no longer have a place in our instrument cases. The present tendency is to simplify their construction as much as possible and to use no greater variety than is absolutely necessary. It is wonderful how much can be done by the trained hands and fingers of a surgeon with a very few instruments, even with a scalpel and a few pairs of forceps. The choice of instruments must necessarily vary with the predilections and training of the individual operator. Certain main principles, however, should always be kept in mind. The surgeon need not encumber himself with such instruments as are seldom needed, or with a multitude of so-called "surgical conveniences" and "automatic appliances." He should, however, always provide himself with a liberal supply of the instruments in

daily use, in order to be prepared for emergencies. None should be retained which do not permit of easy sterilization. Knives should have smooth metal handles and handle and blade should be in one piece. Instruments with grooves, depressions, and notches are to be avoided. Good hæmostatic forceps with smooth blades can now be obtained and are just as effectual as the old ones with grooved faces. All scissors, forceps, needle-holders, and the like should have simple articulations, so that the different parts are readily separable. An instrument with permanent joints cannot be kept surgically clean, and should therefore not be tolerated. A surgeon will often prefer to have his instruments well nickel-plated, as they have a much better appearance and do not rust easily, and, besides, stand better the wear and tear of repeated sterilizations. Since the nickel-plating, however, even when double, has been proved to be not so valuable as was at first hoped, and instruments which are in constant use have soon to be replated, those which are used every day need not be nickel-plated, for by the methods of sterilization now recommended there is comparatively little danger of rust. But for those instruments which are not so often used nickel-plating is advantageous, since it protects them from the action of the air.

Instruments made of aluminium have been recommended, but they are undesirable for the following reasons: (1) they are too expensive; (2) they are too soft; (3) they will not stand repeated sterilization.

In a hospital one nurse or assistant should be given the full charge of the instruments, being held responsible for their proper sterilization and preservation. In private practice the surgeon must give the instruments his personal attention; and even in hospitals he will do well to watch closely the assistant to whom they are intrusted, in order to be sure that the constant careful attention which is absolutely necessary is being paid to them.

It is important to write out lists of the instruments that are used in the different operations and to keep them where they can be easily consulted on each operation day, so that none which will be needed will be forgotten. These lists should be divided into two parts, the first containing the instruments which are sure to be required, the second those that may possibly be needed under certain circumstances, and which should therefore be prepared, although they may be set aside until they are called for. A little foresight and extra trouble will often be repaid in cases of emergency.

Instruments for an Abdominal Section.

Aspirator.	
Cautery (Paquelin).	
Forceps, long dressing	1
long hæmostatic	6
medium hæmostatic	3
small hæmostatic	3
bullet	1
rat-tooth	2
Needles, curved, very large (No. 1)	1
large (No. 4)	2
Needles, intermediate (No. 3)	2
small (No. 2)	2
intestinal (No. 1)	1
transfixion, right curved	1
left curved	1
Needle-holder	1
Retractors, large	2 pairs.
next size smaller	2 "
Scalpels	2
Scissors, long	1 pair.

PLATE III.

FIG. 1.

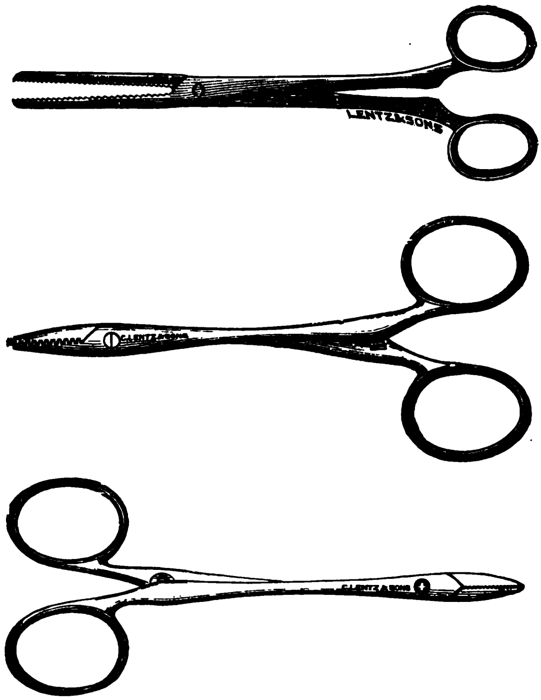
Long dressing forceps. (Robb.)

FIG. 2.

Drainage-tube forceps with Kelly's lock.

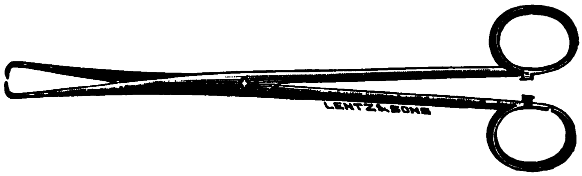
PLATE IV.

Fig. 1.



Hæmostatic forceps.

Fig. 2



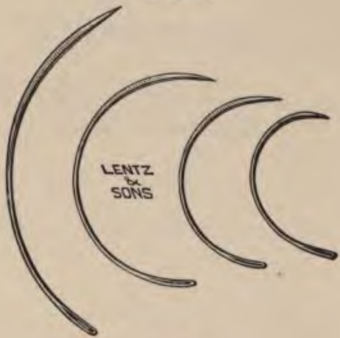
Bullet-forceps.

PLATE V.

FIG. 1.

Rat-tooth forceps.

FIG. 2.



Needles.

FIG. 3.

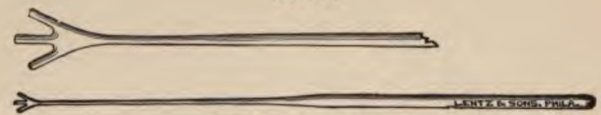
Transfixion needles.

PLATE VI.

FIG. 1.

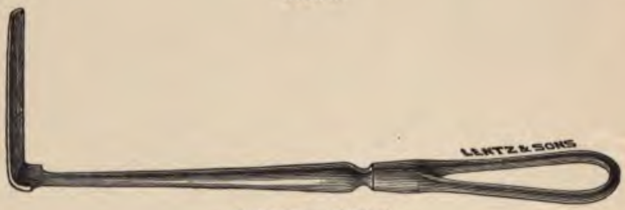
Needle-holder.

FIG. 2.



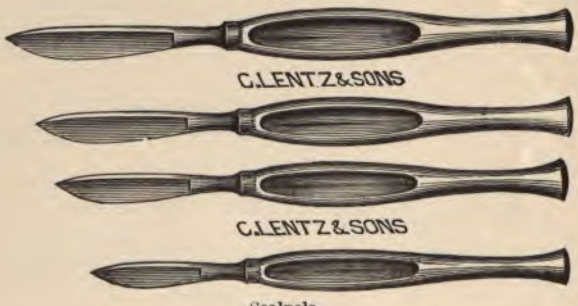
Vaginal packer. (Kelly.)

FIG. 3.



Retractor. (Robb.)

FIG. 4.



Scalpels.

Instruments for an Abdominal Section.—Continued.

Scissors, short . . . . 1 pair.	Sponge-holders . . . . 4 pairs.
Sound, uterine 1	Tenaculum, straight 1
Speculum, Sims' 1	

Additional for Ovarian Cysts.

Trocars, large and small.	Two Nélaton's forceps.
Rubber tubing.	

Additional for Extra-Uterine Pregnancy, Hysteromyomectomy, or Supra-Vaginal Hysterectomy, and Vaginal or Infra-Vaginal Hysterectomy.

One dozen pairs of long hæmostatic forceps.

Two Museux forceps for seizing tumors.

Glass-Ware.

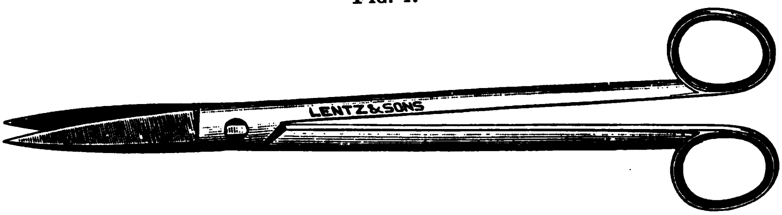
Catheters	2
Flask, sterilized, to receive fluid (contents of cysts, etc.) for examination	1
Nozzles (for irrigation)	2

Instruments for Vaginal Hysterectomy.

Catheter, glass 1	Needle-holders 2
Curette, small 1	Retractors, large . . . . . 1 pair.
Martin's 1	next size smaller . . . 1 "
Forceps, long dissecting 1	small size . . . . 1 "
short dissecting 2	Scalpels 2
long hæmostatic 6	Scissors, long . . . . 1 "
medium hæmostatic 6	sharp-pointed . . . . . 1 "
small hæmostatic 6	Speculum, Sims' 1
bullet 2	Simon's, with handles
Péan's curved 2	and four blades . . . 1
Péan's straight 2	Sound, uterine 1
Needles, curved, large 2	Sponge-holders 4
small 2	Tenaculum, straight 1
medium 2	blunt 1
transfixion, right-curved . . 1	round, sharp 1
straight 1	

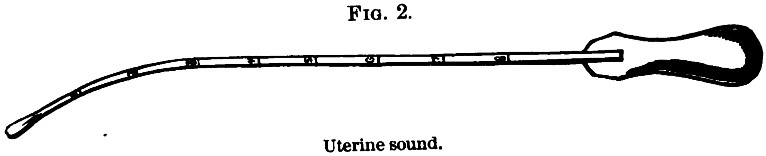
PLATE VII.

FIG. 1.



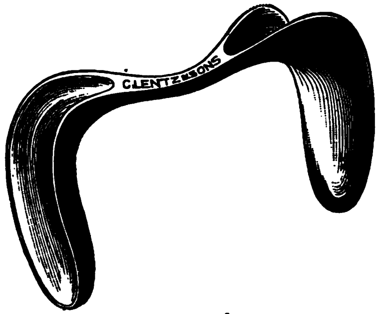
Scissors.

FIG. 2.



Uterine sound.

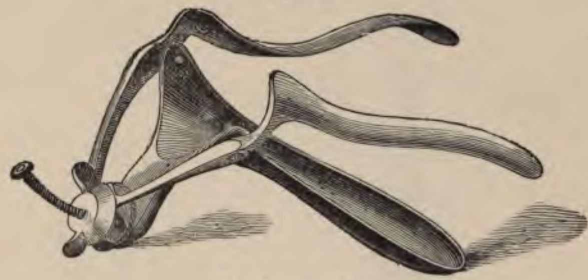
FIG. 3.



Sims' speculum.

PLATE VIII.

FIG. 1.

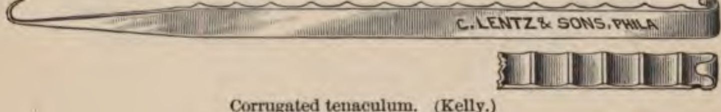


Trivalve speculum.

FIG. 2.

Sponge-holder.

FIG. 3.



Corrugated tenaculum. (Kelly.)

PLATE IX.

Fig. 1.

Trocar.

Fig. 2.

Nélaton's forceps.

Instruments for Perineorrhaphy.

Catheters, glass, small	1	Retractor, small	1
large	1	intermediate	1
Forceps, hæmostatic, long	2	Scalpels	2
intermediate	2	Scissors, right-angled	1 pair.
small	2	left-angled	1 "
long dressing	1	straight-pointed	1 "
bullet	2	Shot-compressor and shot.	
rat-tooth, small	2	Sound, uterine	1
Needles as for abdominal sections (omitting the largest).		Tenaculum, straight	1
Needle-holders	2	Tenacula, curved	2

Instruments for Trachelorrhaphy.

Catheter, glass	2	Needle-holders	2
Curette, Sims'	1	Retractor, small	1
sharp	1	intermediate	1
Martin's blunt, double	1	Scalpels	2
Dilators, different sizes	3	Scissors, straight	1
Forceps, hæmostatic, two of each size	6	Shot-compressor and shot.	
long dressing	1	Sound, uterine	1
rat-tooth dressing	2	Speculum, Sims' small	1
bullet	2	Simon's, with handles and four blades	1
Needles, assorted sizes	8	Tenaculum, straight	1

Instruments for Dilatation of Cervix and Curetting of Uterus.

Catheters, glass	2	Forceps, bullet	2
Catheter, irrigating two-way, small	1	long dressing	1
Curette, Sims' sharp	1	rat-tooth	1
Martin's blunt, double	1	Sound, uterine	1
Dilators, three sizes, Goodell-Ellinger.		Speculum, Sims' small	1
		Simon's, with handles and four blades	1
		Tenaculum, straight	1

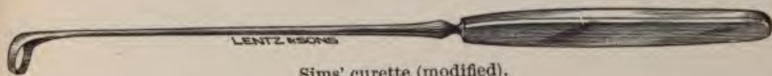
[illegible]

PLATE X.

FIG. 1.

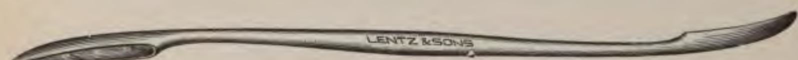
Simon's speculum.

FIG. 2.



Sims' curette (modified).

Martin's curette (modified).



Récamier's curette (modified).

Instruments for Colporrhaphy.

Glass catheters	2
Uterine sound	1
Bullet forceps	2
Tenacula, straight and curved	2
Scalpels	2
Scissors, straight	1
Emmet's right and left curved	2
Dissecting forceps, rat-toothed	2
Hæmostatic forceps, small	6
Long dressing forceps	1
Needles, full curve, three sizes	6
Needle-holders	2
Retractors, two pairs of small and intermediate size	4
Speculum, Simon's	1
Sims'	1
Shot, perforated	6
" -compressor	1

Instruments for Vaginal Myomectomy.

Glass catheters	2
Uterine sound	1
Bullet forceps	2
Tenacula, straight and curved	2
Scalpels	2
Scissors, straight	1
curved on the flat	1
Curettes, Martin's dull and sharp	2
Dilators, Hegar's	4
Goodell-Ellinger	3
Museux volsellum forceps	2
Sponge-holders	4
Speculum, Sims'	1
Simon's, with two handles and four blades	1
Retractors, three sizes . . . pairs	3
Needles, three sizes	6
Needle-holders	2
Long dressing forceps	1
Dissecting forceps, long	1
Écraseur	1

Instruments for Nephrotomy and Nephrectomy.

Scalpels	2
Dissecting forceps, small rat-toothed	2
long rat-toothed	2
Dressing forceps	1
Hæmostatic forceps, stout	12
long	12
Retractors, Halsted's large	2
Robb's large and medium-sized	4
Scissors, straight	2
Scissors, curved on the flat	1
Tenacula, straight	2
Needles, three sizes	6
Needle-holders	2
Return-flow douche nozzle	1
Transfixion or aneurism needle	1
Hysterectomy forceps, curved	2
Searching needle	1
Lithotomy forceps	1
Rubber drainage-tube.	

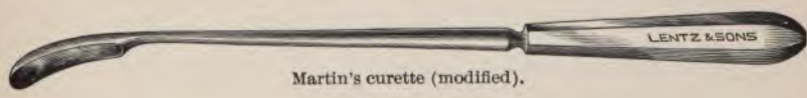
PLATE X.

FIG. 1.

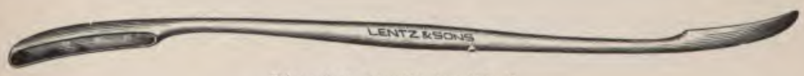
Simon's speculum.

FIG. 2.

Sims' curette (modified).



Martin's curette (modified).



Récamier's curette (modified).

PLATE XI.

Fig. 1.

Modified Goodell-Ellinger dilator (smallest size).

Fig. 2.

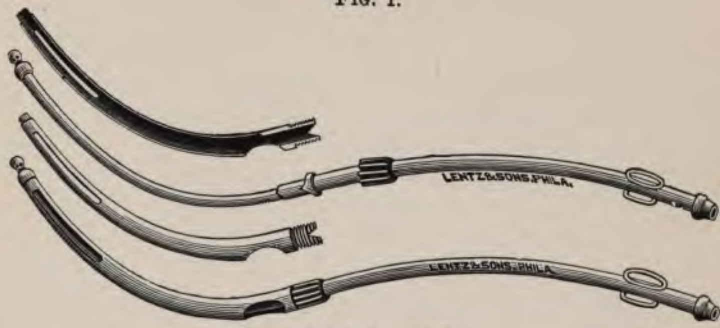
Hegar's dilator.

Fig. 3.

Shot-compressor.

PLATE XII.

FIG. 1.

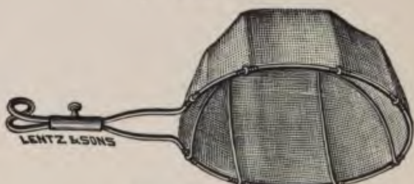


Two-way catheter. (Kelly.)

FIG. 2.

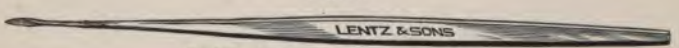
Chloroform-bottle.

FIG. 3.

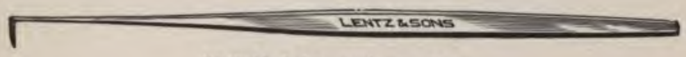


Chloroform-inhaler.

FIG. 4.



Probe-pointed tenaculum. (Kelly.)



Knife-bladed tenaculum. (Kelly.)

List for Abdominal Operations Outside of Hospital.

Aspirator.
Instruments in bags.
Basins for instruments.
Cautery (Paquelin).
Coats for doctors and nurses.
Solutions:* five hundred cubic centimetres bichloride solution (1 to 20).
five hundred cubic centimetres crude carbolic acid.
normal salt.
Crystals of permanganate of potassium and oxalic acid.
Soap and two brushes.
Rubber sheets and ovariotomy pad.
Sterilized towels.
Ether and cone.
Chloroform and inhaler.
Hypodermic syringe.
Brandy.
Strychnine tablets ($\frac{1}{60}$ grain).
Rubber tubing.
Six sponges (gauze, 24).
Silk ligatures, four sizes (three tubes).
Catgut ligatures, three or four sizes.
Silkworm-gut, two sizes.
Scultetus bandage.
Safety-pins.
Sterilized gauze.
Strips of gauze for dressing.
Celloidin.
Sterilized cotton.
Iodoform and boric acid powder.
Glass graduate or agate ware pitcher.

List for Perineal and other Minor Operations.

Instruments.
Leg-holder.
Ligatures.
Sterilized stockings.
Perineal pad.
Douche bag.
Dressings.
Bandages.

Instruments and Materials for making Applications.

One Sims speculum, small.
One pair of bullet-forceps.
One pair of long dressing-forceps.
One pair of straight-pointed scissors.
One vaginal packer.
One aluminium applicator.
Vaseline.
Churchill's tincture of iodine.
Cotton pledgets.
Two basins.
Fifty-per-cent. boro-glycerin solution.
Tampons of cotton and wool.

* Carbolic acid, tablets of bichloride of mercury and of sodium chloride for solutions.

Instruments for Catheterization of the Ureter.

Applicator	1	Forceps, long, mouse-tooth	1 pair.
Catheters, glass	2	Head mirror	1
ureteral	3	Searcher, ureteral	1
Dilators, ureteral, 8–10 mm.	3	Syringe	1
Endoscopes with calibrators, 8–10 mm.	3		

The problem of discovering a simple and effectual way of sterilizing metal instruments has been a difficult one. Many methods have been employed, but none is more satisfactory than that introduced by Schimmelbusch, to be described presently. The exposure of the instruments to the flame of a Bunsen burner or spirit lamp is an effectual way of sterilizing them, but the method has many disadvantages. The time required and the danger of overheating and blackening the instruments, besides at the same time of dulling them, make it useless except on rare occasions or when, perhaps, a single scalpel or needle is required for immediate use. The hot-air sterilizers, which have been introduced especially for the sterilization of metal instruments, have been found to be unsatisfactory for this purpose. To make sure that the instruments are completely sterile, it is necessary to keep them in the hot-air sterilizer at a temperature of from 150° to 180° C. (300°–350° F.) for at least two hours. When one remembers that at least twenty minutes or a half an hour is necessary to bring the sterilizer to this temperature, and that some time will be required to allow the instruments to cool

down, it will be seen that more than two hours are required for the whole process. Of course this objection may be obviated by following the recommendation of Poupinel, who suggests that the instruments should be placed in tight metal boxes (Fig. 8) and sterilized on the day before the operation, being then allowed to remain in the boxes until just before they

FIG. 8.

Instruments in metal box.

are needed. But in any case the inconvenience is great, and still another serious objection is found in the fact that, in spite of the greatest care, instruments thus treated will almost surely rust, even when the new "ventilated" disinfecting ovens are employed. Attempts to shorten the time required for sterilizing by hot air have given unfavorable results, and it has also been proved that exposure to a temperature above 180° C. is deleterious to the temper of the steel, and affects the hardness and sharpness of the cutting instruments.

Some surgeons prefer to sterilize the instruments by means of steam, and employ the Arnold or some

other steam sterilizer. The instruments are put in bags made of "bird's-eye" or "towel" linen, which are then placed in the sterilizer and exposed to a temperature of 100° C. for an hour. The mouths of the bags are provided with draw-strings, by means of which they can be lifted from the sterilizer, and the instruments are turned out into the trays, which have been sterilized and which contain enough sterile water to cover them completely. If the instruments are allowed to dry in the sterilizer they are almost sure to rust or to become discolored. The time of sterilization may be somewhat reduced if an autoclave be used, but all these methods of sterilization by steam are also open to the objection that they require too long a time and are apt to injure the instruments.

From what has already been said with regard to disinfection by chemical agents in Chapter II., it will be readily understood why, if only on the grounds of the injury done to the tissues, the method so much in vogue formerly, of simply placing the instruments in a solution of carbolic acid for a short time before the operation, must now be discarded. But besides this serious objection, solutions of carbolic acid which are concentrated enough to have any decided germicidal power may be injurious to those who handle the instruments. In addition to the grave local lesions set up in the hands of susceptible individuals, instances of carboluria and of the severe general symptoms of carbolic-acid poisoning have more than once been noted simply from the effects of handling instruments

kept soaking in the solutions during prolonged operations.

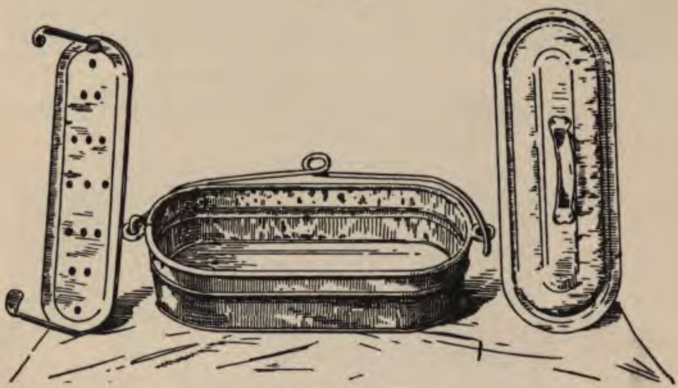
Instead, therefore, of employing dry heat or steam, or trusting to chemical solutions, surgeons during the past few years have had recourse to the boiling of the instruments in water and other fluids. The French writers have recommended boiling glycerin and oil of various kinds, but the use of these need not be discussed here, since in simple boiling water we have an efficient and speedy disinfectant for instruments. Five minutes suffice for complete sterilization. The most serious objection to the use of plain water, which has been very warmly recommended by Dandrohn, Redard, and others, lies in the serious damage done to the instruments. If they are placed in ordinary cold water and boiled, they will often be found to be studded with spots or even covered thickly with rust. The danger can to a great extent be avoided if the water be boiled for some time before the instruments are placed in it, and the addition of some alkali to the boiling water is a sure preventive, the one best suited for the purpose, as shown by Schimmelbusch, being ordinary washing-soda (sodium carbonate).

The method employed by Schimmelbusch for sterilizing instruments is by far the most convenient and effective for general employment, and has been used for some time in many operating-rooms with universally satisfactory results. It was first introduced into von Bergmann's clinic in Berlin, and, while free from objection from a bacteriological stand-point, has

the additional advantages of requiring very little time, of being inexpensive, and of entirely doing away with the danger of rust. Soda also adds to the disinfectant power of the boiling water. Repeated experiments made to test the efficacy of the method have shown that a boiling one-per-cent. soda solution kills all known pyogenic organisms in from two to three seconds, while anthrax spores are all destroyed after an exposure of two minutes. The procedure is as follows: the instruments (which have been thoroughly cleansed after the preceding operation) are boiled for five minutes in a one-per-cent. solution of carbonate of sodium. Any vessel can be made to serve for this purpose if one is operating in a private house, but in hospitals and operating-rooms it is convenient to have a specially-constructed apparatus made of copper, agate-ware, or nickel. This consists of an oblong boiler fitted with a cover. The heat beneath can be supplied by Bunsen burners ("wreaths") or by a spirit-lamp; or where these cannot be obtained, the boiler can be set directly upon a stove. The size of the boiler required will depend, of course, upon the amount of work to be done. In hospitals one of large size will be necessary, but in private practice or in small operating-rooms a boiler twenty to forty centimetres long (8–16 inches), fifteen to twenty centimetres wide (5½–8 inches), and ten to twelve centimeters (4–4½ inches) deep will answer every purpose (Fig. 9). In making the soda solution, one soon learns how much, approximately, of the dry soda to add to a given

amount of water without actually weighing it; but to save time and insure accuracy, a concentrated solution of known strength may be kept ready, so that by simply diluting it a one-per-cent. solution may be made

FIG. 9.

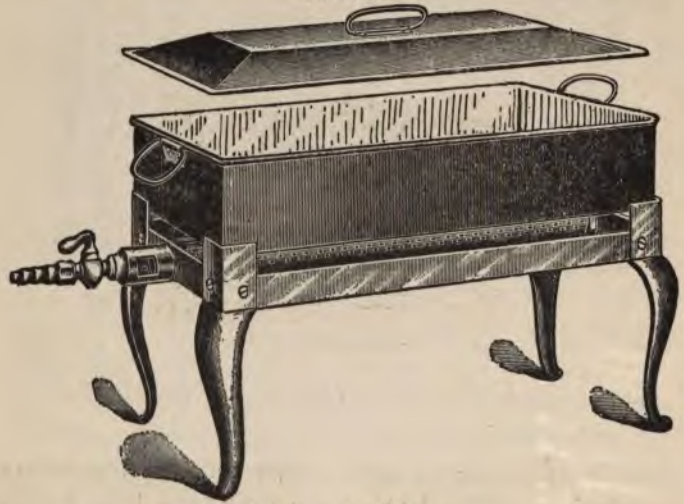


Boiler for soda solution.

whenever it is required. In order to facilitate the introduction and removal of the instruments, a flat wire basket which fits into the boiler will be found very convenient. (Fig. 10.) After they have been boiled for five minutes the wire basket containing the instruments is removed, and the latter are turned out into sterilized trays which contain sufficient warm sterilized water to cover them. Instead of simple water, a cold (previously boiled) one-per-cent. soda solution may be used in the trays, or a solution which contains one per cent. of soda and one per cent. of carbolic acid. The addition of the latter would seem, how-

ever, to be entirely unnecessary. Between operations which follow one another in rapid succession, or if some of them by chance have come in contact with non-sterile material during an operation, the instruments may, after being carefully washed in cold water, be quickly resterilized in the boiling soda solution.

FIG. 10.



Instrument sterilizer.

The procedure should be actually timed by a watch kept hanging up in the operating-room.

The most satisfactory vessels to keep the instruments in at the time of the operation are trays made of thick glass (Plate XIII., Fig. 1), which are easily sterilized. On account of the cost, however, great care must be exercised while sterilizing them or washing them

PLATE XIII.

FIG. 1.—Glass dishes.

FIG. 2.—Sterilized towels in three-per-cent. carbolic solution.
FIG. 3.—Sterile cotton in glass jar.
FIG. 4.—Sponges in three-per-cent. carbolic acid solution.

FIG. 5.—Sterilized tampons of lamb's wool and absorbent cotton in glass jar.
FIG. 6.—Sterilized gauze in glass jar.
FIG. 7.—Ligatures in glass jar.

FIG. 8.—Gauze drains.

in hot water, else they are liable to be broken. Glass dishes are best sterilized by means of dry heat, but besides the length of time required and the risk of breakage, the bulkiness of the glass-ware which is used renders the procedure very inconvenient in practice. The smooth surface of glass dishes, which can easily be kept perfectly clean, makes it possible to render them sterile by mechanical means supplemented by sufficiently strong solutions of bichloride of mercury. They are first washed thoroughly with water and then filled to the brim with an aqueous solution of bichloride of mercury (one to five hundred), which is allowed to remain in them for an hour before they are needed for use. Just before the operation they are finally rinsed out well with sterile water and after being placed upon the table are filled with enough sterilized water or salt solution to cover the instruments. If they are required for a second operation following closely upon the first, they may be cleansed by rinsing them out with cold water to which hot water is cautiously added, then with a one to five-hundred bichloride solution, and lastly with sterilized salt solution. To clean them before putting them away after the operations are over for the day, they are washed out thoroughly with soap and warm water and are then turned upside down and allowed to drain until they are perfectly dry.

If glass dishes cannot be obtained, trays made of hard rubber, agate-ware, or porcelain may be substituted for them. They can be sterilized in the

same way as the glass dishes. (Figs. 11, 12, and 13.)

The instruments which have been used should first be washed in cold water, in order to remove all pus, blood, or tissue-particles. They are next immersed in hot soda solution and thoroughly scrubbed with soap

Fig. 11.

and brush. After being rinsed off they are wiped dry with a soft towel and polished with a piece of chamois skin. Finally, they are boiled for five minutes in a one-per-cent. soda solution and carefully wiped dry,

Fig. 12.

after which they may be put away in their proper places in the instrument case. Instruments thus carefully and regularly treated will never rust and will always be clean and bright.

In all these manipulations instruments with cutting edges should be handled with particular care, in order that they may not be dulled. The edges should not be allowed to come in contact with hard surfaces, as they would do if they were roughly handled and carelessly dumped into the trays. Great care is also necessary when wiping off the blades. In those instruments the parts of which are connected by means of the French lock it is especially important that no moisture should be allowed to remain in the joints, and the

FIG. 13.

Robb's aseptic ligature tray.

numbers on the several parts should be carefully noted, so that those which correspond may be joined together. Neglect of this simple rule will soon ruin the instruments. Force should never be exercised in adjusting them, as the pivots are delicate and the slightest roughness will prevent their accurate apposition, so that after a short time the joints will become so loose as to be quite useless.

The instrument cases are described in Chapter XI.

When a surgeon wishes to carry sterilized instru-

ments with him to avoid the necessity of sterilizing them at a private house, they should be boiled in the one-per-cent. soda solution, wiped with a sterilized towel, and put in sterilized bags, which are then placed in tight metal boxes made for the purpose, the latter having been previously sterilized by dry heat; the boxes are to be left unopened until the time of the operation. It is probably safe, however, to carry the sterilized instruments in the sterilized bags with the other things in the telescope valise, omitting the use of the metal box. The ordinary case or loose bag formerly employed for carrying instruments should, of course, no longer be used. It will, as a rule, be found more convenient, even for operations in private houses, to carry a small apparatus for sterilizing instruments, but, as a matter of fact, we can find in almost any house a vessel in which they can be boiled.

CHAPTER VI.

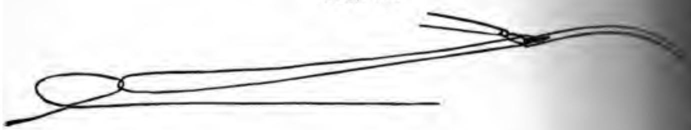
ASEPTIC SUTURES, LIGATURES, AND CARRIERS—SUTURE MATERIALS—STERILIZATION AND PRESERVATION OF THE VARIOUS KINDS.

WE have a variety of materials from which to select our sutures and ligatures. The substances commonly employed are the cable twist silk, silkworm-gut, catgut, silver wire, kangaroo tendon, and horse-hair; and of these silk, silkworm-gut, and catgut are most frequently used. No one suture material will suffice for all purposes, although silk can be made available for the majority of cases. Whatever we use, the main point is that it shall be sterile, and, as we shall see later, we may have a material which at first sight appears in every way adapted for our purpose, and yet presents such apparently insuperable difficulties in the way of rendering it sterile that, in the eyes of the aseptic surgeon, the risks accompanying its use may more than overbalance its other advantages. The material must also be smooth and pliable but not brittle, and it is but natural that, *cæteris paribus*, we should choose something not too costly and which is easily obtainable. If I were asked to state my preference in regard to the materials in ordinary use, I would, on the ground of the bacteriological experiments made by Dr. Ghriskey and myself, place

them in the following order; (1) silkworm-gut, fine and coarse; (2) surgeon's cable twist silk, Nos. 1, 2, 3, 4, and 5; (3) silver wire, fine and coarse; (4) catgut, sizes a, b, c, d, and e. Since, however, silk is the material most commonly used, we will take it up first.

When using the surgeon's cable twist, five sizes are to be kept in stock: No. 1 (fine) is very necessary when carriers are to be employed. (Fig. 14.) The car-

Fig. 14.



Needle armed with a carrier.

rier is of the greatest convenience, as it does away with the necessity of having a large number of needles and also facilitates quickness in the performance of an operation. It consists of a piece of silk fifty centimetres (nineteen inches) in length, and is prepared in the following way. The surgeon passes the two ends through the eye of the needle from opposite directions. An assistant then holds the needle, or it may be allowed to hang down over the side of the hand while the two ends are tied snugly in a knot; slight traction being made on the loop thus formed, the knot is securely fixed in place immediately behind the eye of the needle. As the operator passes the needle through the tissues, each suture, as it is to be introduced, is

en inches) in length. The third
ial ligatures, each forty centi-
fourth holds eight fine ligatures
centimetres (nineteen inches)
of carriers will be necessary,
one for each of the several
which are likely to be re-
operation. After the silk
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The full reels are placed
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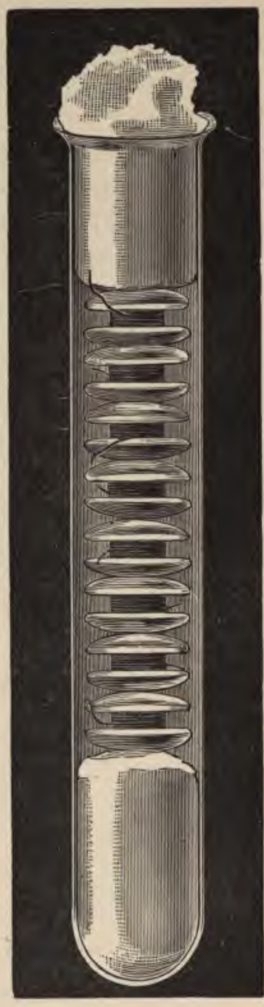
FIG. 15.

Glass reels for ligatures.

FIG. 16.

FIG. 17.

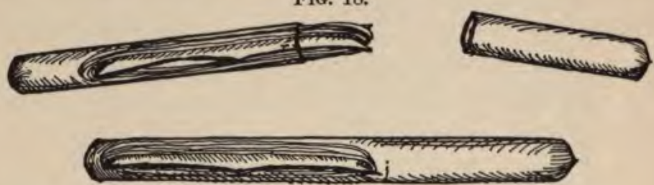


Ignition test-tubes with ligatures on reels.

forty centimetres (sixteen inches) in length. The third reel is for ten superficial ligatures, each forty centimetres in length; the fourth holds eight fine ligatures (for carriers), each fifty centimetres (nineteen inches) in length. This number of carriers will be necessary, as it is important to have one for each of the several needles of different sizes which are likely to be required in the course of the operation. After the silk has been cut into the required lengths, the strands are bunched into fours and wound together (not separately) on the glass reels. The full reels are placed in the heavy glass tubes, the mouth of each tube being plugged with ordinary cotton batting. The empty tubes, plugged with cotton, should have been previously sterilized in the hot-air oven. Absorbent cotton should not be used for this plug, as it will take up moisture from the air, and fungi will be much more likely to grow through it. The tubes with the ligatures in them are to be sterilized in the Arnold steam sterilizer for one hour the first day and for half an hour on each of the two succeeding days, or in the autoclave on two successive days for half an hour each time. It is, perhaps, not absolutely necessary to sterilize them more than twice, but it is safer to adopt the routine method of sterilizing on three successive days. When the ligatures have thus been rendered aseptic they will remain so indefinitely if the tubes are kept well plugged and in a dry place. Instead of the arrangement mentioned above, the different sizes of ligatures may be kept in separate tubes, and each tube will then

have to be opened only when the particular size of suture which it contains is required. If the plug is carefully held by its outer surface, and is replaced when one reel is removed, the others, if separated by small plugs, will not be contaminated, provided that we are careful either to allow the reels which we require to roll out of the tube into the solution prepared for them, or else (and this is perhaps the safer way) to remove them from the tube by means of a pair of sterilized forceps. If, however, there should be the least suspicion that the ligatures on the remaining reels

FIG. 18.



Sterilized catgut in sealed glass tubes.

have become contaminated during this manipulation, the tube with its contents must again be placed in the sterilizer or autoclave for an hour. The tubes can be kept in glass jars like those employed by confectioners, each jar as well as each tube being provided with a label bearing the date of sterilization. Plate XIII, Fig. 7. Some surgeons prefer to resterilize their silk ligatures immediately before every operation. This can easily be done by placing the tubes in the Arnold sterilizer, or the reels may be taken from the tubes and boiled with the instruments in a one-per-cent. soda solution. Silk ligatures will not, however, bear steam-

ing many times, as the procedure, if repeated too often, will render them brittle. The glass jars which have been recommended by so many, in which the ligatures are kept wound on reels, the ends being allowed to come out through small openings, are very objectionable. The ligatures are almost certain to become contaminated, and no device suggested for overcoming this difficulty has proved satisfactory. The older custom of keeping ligatures in antiseptic oils and fluids is even more reprehensible.

Silkworm-gut is a substance which is excellently adapted for being employed as a suture material, and it is a pity that it does not admit of more universal application. It has a smooth surface, is compact and free from interstices, and in consequence sutures of silkworm-gut may be allowed to remain in position longer than silk sutures without injury to the tissues. This is, of course, of great advantage in such a wound as we have, for example, after a perineorrhaphy, and in fact in all cases in which it is desirable that the sutures shall remain in position for more than a few days. Silkworm-gut is easily introduced and moulds itself readily to any desired position in a wound. When properly applied, it does not produce the same constriction of the tissues as either silk or silver wire, but acts more like a supporting splint. The sutures can be very easily removed when desired, and experiments have shown that silkworm-gut resists the invasion of bacteria much better than silk or catgut which has been left in for the same length of time. It is

best employed in two sizes, the coarse and the fine, and may be bought in bundles of one hundred strands, at a cost of seventy-five cents a bundle. Silkworm-gut is sometimes stained red, but this procedure is not necessary, although the ligature is in this way rendered more easily visible. In preparing it for use, the twisted ends of the strands having been cut off, a dozen ligatures, folded once, are placed lengthwise in each of the glass tubes in which they are to be kept. The methods which we described for the sterilization and preservation of silk sutures will apply equally well to sutures of silkworm-gut. They should be placed in a sterilized tray containing sterile water or salt solution half an hour before the operation. This renders them more pliable, and they are not so likely to break as when they are used perfectly dry. Any silkworm-gut remaining after an operation can be rinsed off and resterilized for another time by repeating the process described above. As a rule, it is better not to make a complete knot when employing silkworm-gut, but to use instead only the first stroke of the surgeon's knot, which will hold quite well. The advantage of this is that the threads lie flat, the sutures can afterwards be tightened or loosened at will, and the parts are kept in perfect apposition without any constriction of the tissues.

Silver wire is now frequently used, as experiments tend to show that the metal has a definite antiseptic effect in the tissues. It may be used subcutaneously or as a deep suture. Otherwise it is less desirable than

silkworm gut, as it is more expensive and is more apt to injure the tissues. It can be bought in different sizes, and generally comes wound on spools. It can be sterilized by steam heat, by means of dry heat, or by boiling in the one-per-cent. solution of soda.

Catgut appeared to be an almost ideal material for sutures, but, unfortunately, we had no thoroughly reliable method of rendering it absolutely sterile without at the same time making it so weak as to unfit it for our purpose. When properly handled, it supports the tissues for a sufficient length of time to allow of a thorough approximation of the parts, and after it has served its purpose the suture is absorbed. Just as soon, then, as we found a reliable method for sterilizing catgut which did not at the same time destroy its other necessary properties, we acquired a ligature material of the highest value. Different specimens of catgut vary greatly, and, although some of the methods of sterilization which are advocated are perhaps effective in the majority of instances, it not infrequently happens that a few of the strands are not rendered sterile, and many cases of suppuration or death following operations have been directly traceable to the use of catgut ligatures.

There are several methods now adopted for sterilization of catgut, but I shall only refer to a few of those most commonly employed.

(1) *Cumol Method.*—The strands of catgut are rolled separately in rings and heated gradually in a hot-air oven. After the temperature has reached 70° C., it is

maintained at this point, and the catgut is allowed to remain in the oven for about two hours. Exposure to dry heat of 100° C. or over renders catgut brittle.

The rings are then transferred to a glass vessel containing cumol, which is heated in a sand-bath to 155°–165° C. for one hour.

An ordinary enamelled saucepan can be used for holding the sand. The beaker containing the cumol is surrounded for two-thirds of the way up the sides with sand in order to insure the rapid and regular distribution of the heat.

The top of the beaker should be covered with a piece of wire gauze, since, although cumol is not explosive, it ignites if it is brought in direct contact with the flame.

Two Bunsen burners may be employed at first, and as soon as the thermometer shows 155° C. one may be withdrawn, after which a temperature of 155°–165° C. can be easily maintained for one hour. Krönig holds that it is impossible to do the catgut harm by overheating, but other authorities are of the opinion that exposure to a temperature of over 165° C. for any length of time renders the strands brittle.

The catgut is next transferred to a sterilized vessel containing chemically pure benzine and allowed to remain for three hours, being afterwards preserved in absolute alcohol.

If preferred, however, it may be kept in the benzine till shortly before it is required for use, in which case it is only necessary to allow it to lie on a sterilized towel

for an hour, in order that the benzine may have time to completely evaporate.

By this method we can obtain a suture material which is not only sterile but is not impregnated with any irritating substance.

Krönig's method of catgut sterilization, modified by Clark and Miller (The Johns Hopkins Hospital Bulletin, No. 114, 1900), has proved to be perfect as regards its germicidal properties, and when properly carried out gives a strong, pliable catgut. In order to preserve the catgut in the tissues for a longer period of time than six to ten days, Miller has made use of a combination of formalin and cumol. He suggests soaking the catgut in a four-per-cent. formaldehyde or a ten-per-cent. formalin solution for ten hours; it is then washed for several hours in running water, dried, and sterilized by the cumol method. Miller has found that this catgut will last from fourteen to eighteen days. If soaked too long, or if the formalin is not thoroughly washed out, the catgut loses its strength. Catgut prepared in this way, as Miller has conclusively demonstrated, is free from bacteria.

(2) *Hofmeister's Method.*—The catgut is wound very tightly on glass plates and immersed in a two to four per cent. solution of formalin for from twelve to forty-eight hours. It is then washed in flowing water for at least twelve hours. It is then boiled in water for from ten to thirty minutes, after which it is placed in a mixture of absolute alcohol with five-per-cent. glycerin and one per cent. of bichloride of mercury, and left

there until it is to be used, when it is washed off in sterile water or sterile salt solution.

Senn has substituted ten-per-cent. iodoform for the bichloride of mercury, and finds the suture just as sterile and less irritating.

(3) *Claudius' Method.*—Commercial raw catgut, without any preliminary preparation, is wound on glass plates and immersed in a one-per-cent. aqueous solution of iodine and potassium iodide, in which it is left for at least seven days. When it is to be used it is washed off in a three-per-cent. carbolic solution or in an indifferent sterile solution.

(4) A fourth method is as follows: Six strands of catgut of different sizes, each forty centimetres (sixteen inches) long, are wound on a glass reel. A number of these reels are placed in a bottle of ninety-five-per-cent. alcohol, care being taken that the catgut is completely covered, some slight allowance also being made for evaporation. The mouth having been plugged with cotton, the bottle is placed in a water-bath, which is heated until the alcohol boils. The heating is repeated on three successive days. The stopper is then put in, being protected with paraffine or rubber protective, unless the ligatures are required for immediate use. When required, some of the reels may be taken from the bottle by means of a pair of sterilized forceps. If it is thought preferable the strands on each reel may be all of the same calibre, in which case it will be advisable to have a complete series of the reels in the same bottle. We have been using with some satisfac-

tion Kiliani's dry catgut in different sizes; also St. John Levan's and Van Horn's chromicized catgut. It should be said, however, that in using the large size of the chromicized gut we have found that the suture sometimes does not become absorbed, but gradually

Fig. 18A.

Tube of sterilized catgut.

works its way to the surface and is then discharged.

When applying ligatures it is of the greatest importance, as has been previously pointed out, to avoid any undue constriction of the tissues which might lead to obstruction of the circulation and diminish the normal resistance of the parts. The manipulation of the sutures and ligatures is too often a weak point in the technique of surgeons. The ligatures are sometimes cut into lengths just before the operation, and the ends are not infrequently allowed to hang down over the edge of the dish in which they are arranged. Sometimes they are brought in contact with an unsterilized object in being passed from the instrument-table to the operator, and even after they have reached his hands the ligatures are still often in great danger of becoming infected, so that it may be truthfully said that where a large number are employed during an operation it is a wonder that they can all be kept aseptic.

CHAPTER VII.

STERILIZED DRESSINGS—COTTON—GAUZES—BANDAGES—TAMPONS—SPONGES.

THE early surgeons, and particularly those in hospital practice, laid great stress upon the dexterous application of many complicated bandages and dressings, and looked with some pardonable pride upon their parallels and angles, their reverses from straight lines, and the even, smooth dressings which were then considered an essential part of a good surgical technique. As a matter of fact, the application of the non-sterile dressing of those days often did more harm than good, and we can hardly be surprised that many surgeons were led to believe that they could obtain better results from treating wounds by exposure to the air than by covering them with gauze and bandages,—results which we are less likely to question, since it has been proved how much greater are the dangers of infection by contact than those of infection from the air. The various efforts to obtain a more satisfactory method of dressing wounds need not be discussed here. Many of us still remember the treatment by the *earth dressing*, so lauded by Addinell Hewson. In studying the statistics of wounds which have been treated in this way, one is struck by the number of cases in which the patients subsequently died of lockjaw, and to-day

a surgeon would be thought very rash if he applied to the wound, without sterilization, a substance known to be the natural habitat of the tetanus-bacillus.

The occlusive dressing has been much employed, and not without reason, inasmuch as it imitates more or less closely nature's own method. It has, indeed, its peculiar dangers, but, as will be shown later, it is often valuable in abdominal surgery.

When a wound is not to be closed hermetically it is important to apply a dressing which, while being itself free from pathogenic bacteria, will prevent the access of micro-organisms from the outside, and at the same time will thoroughly absorb the secretions from the wound and prevent their subsequent decomposition. A great variety of substances have been recommended for their absorptive power, among them straw, bran, sand, ashes, tan-bark, tow, moss, wood, and sawdust, but no one of these is so useful or so generally applicable as cotton or gauze, which has been made capable of absorbing by the removal of all fatty substances from it. Good absorbent cotton can be bought for from forty to sixty dollars per hundred pounds. It is generally sold in rolls, each weighing one pound. Common cheese-cloth one yard wide costs about five dollars per hundred yards. For dressings it can be cut into lengths of two metres or of two yards and boiled for half an hour in a one-per-cent. solution of carbolic acid and soda, and then thoroughly rinsed in sterile water. The manufacturers have reaped bounteous harvests from the preparation of the so-called "antiseptic gauzes,"

made by saturating absorbent gauze with solutions of bichloride of mercury, carbolic acid, boric acid, salicylic acid, and cyanide of mercury and zinc. But now we know that all these methods of disinfection are inefficient, and even if the materials are in a sterile condition when packed by the manufacturers, the numerous subsequent handlings which they undergo before they come in contact with a wound would almost certainly lead to contamination. And if contamination can occur so easily in this way, surely nothing need be said of the many instances in which "antiseptic gauze" has been thrown beneath the buggy seat, or at the bottom of not over-clean boxes or bags, to be placed a short time afterwards as a dressing upon a wound which it is meant to protect.

The surgeon of to-day does not need to acquaint himself with these fancy preparations, except to learn to avoid them. Only in rare instances do we require a gauze impregnated with antiseptic substances (*vide* permanganate and iodoform gauze). It will generally be sufficient if we render our gauze and cotton free from pathogenic micro-organisms before applying them to wounds. The methods are not complicated, and surgeons are to be congratulated upon the immense simplification of dressings and of the ways of applying them which have been given to us through the recent advances in our knowledge of the different modes of infection and of the way in which it is to be avoided.

Absorbent cotton, absorbent gauze, and bandages should be sterilized in the Arnold sterilizer or in the

autoclave. Exposure for three-quarters of an hour to steam at 100° C. serves to render all these substances, if not packed or rolled together too tightly, absolutely sterile. It is best to sterilize the dressings shortly before each operation, and in large operating-rooms where several cases are operated upon daily, it is necessary to have several steam sterilizers. They are made in such numbers now that they are comparatively inexpensive. But the question will be asked, How will the application of simple sterile gauze to wounds, in the absence of chemical substances, prevent the decomposition of the secretions from the wound which are taken up by the dressing? The answer is so simple that it seems strange that we should only recently have appreciated it. One of the first requisites for the growth of micro-organisms is moisture. Bacteria do not multiply in dry substances. Good gauze and cotton permit of the constant evaporation of moisture from them, and so prevent bacterial growth. They do not remain damp long after being removed from the sterilizer, so that the dressings may be applied almost immediately after the sterilization has been completed. It is rather better, however, to place the dressings, which have been exposed to the steam, in a drying chamber for a short time before they are used. By using the autoclave this second step is rendered unnecessary. Dressings impregnated with antiseptics are useless, inasmuch as, in the first place, the presence of powerful antiseptics in sufficient concentration to have any germicidal effect would

irritate the skin and the wound, and, secondly, all antiseptics are quite inactive in dry gauzes, when there is but little exudation, and therefore, in order to obtain any benefit from them, the dressing would have to be applied wet, whereas, as we have said, the dryness of the gauze constitutes in itself a great safeguard.

In order to have a stock of thoroughly dry and sterile cotton always on hand, the absorbent cotton may be cut into pieces of convenient size and securely wrapped in a towel or in a piece of gauze several layers thick. The bundle, securely but not too tightly fastened, is then sterilized in the Arnold sterilizer for from forty-five to sixty minutes, or in the autoclave for half an hour, and, after being allowed to dry in the air in a room where there is no dust, is kept until required for use in a closed glass jar or in a tin box. Plate XIII., Fig. 3. Sterilized gauze may be preserved in the same way. Plate XIII., Fig. 6. Before opening these sterilized packs the hands should either be disinfected or covered with rubber gloves taken from a jar of five-per-cent. carbolic acid solution, or the pack may be removed with sterilized forceps. If any cotton or gauze is left over after the package has been opened, it may be again wrapped up and resterilized.

In order to prevent contamination of the field of operation, it is necessary to surround it with sterilized gauze or towels. The latter are made of the ordinary towelling with plain hemmed edges. A supply of these, already sterilized, may be kept in a covered glass

jar, dry or filled with a one to five hundred sublimate solution or a three-per-cent. carbolic acid solution, so that they are ready at all times. Plate XIII., Fig. 2. In the latter case, before being used, where they will come in contact directly or indirectly with the field of operation, they should first be rinsed in sterile water.

Iodoform gauze is occasionally required for various purposes, and may be prepared in the following manner: plain gauze is cut into lengths of three metres (about three yards) each, and folded lengthwise. For the iodoform mixture enough castile soap is mixed with two hundred cubic centimetres (℥vi) of a one-per-cent. aqueous solution of carbolic acid to make good suds; forty-five grammes (ʒxii) of powdered iodoform are then added, and the whole is thoroughly mixed. The quantities given above will be sufficient for the preparation of three metres of gauze. The gauze is immersed in the mixture, which must be well rubbed into the meshes. It is then rolled up, placed in a towel, sterilized, and kept in a sterile jar. In cutting off pieces of gauze for use, the hands must be sterilized or sterilized rubber gloves must be worn and a pair of sterilized scissors used. Such precautions as these are very important if we wish to prevent any possibility of contamination. When the iodoform gauze is to be used for dressing plastic cases, it is convenient to have it cut into strips ninety-four centimetres (36 inches) long and eight centimetres (3 inches) wide. Each strip is rolled up separately, and several of these rolls are preserved in a

sterilized glass jar. When required for use, they can be taken from the jar with sterilized forceps.

Permanganate gauze is not infrequently used for dressings, and does a great deal to diminish the odor that is so objectionable in cases of cancer of the cervix and uterus, and elsewhere where there is any bad-smelling discharge. The ordinary gauze is cut into lengths of one metre (39 inches) each, folded lengthwise, sterilized for one hour, and then saturated with a one-per-cent. aqueous solution of permanganate of potassium (ten grammes (160 grains) of the crystals of permanganate of potassium to one thousand cubic centimetres (33½ ounces) of hot water). The gauze is cut and rolled in the same way as the iodoformized gauze, and should be preserved in a colored glass jar.

Subiodide of bismuth may also be rubbed into gauze which is to be used for plastic cases. For three metres (3 yards 9 inches) of gauze a mixture of forty-five grammes (ʒxii) of pure subiodide of bismuth with one hundred and fifty cubic centimetres (℥v) of water and thirty cubic centimeters (℥i) of glycerin will be sufficient.

Tampons of lamb's wool are especially useful when a non-absorbent material is desired. Such a tampon is very elastic and serves excellently as a support. A piece of wool thirty centimetres long and three centimeters wide (11 inches by 1 inch) is twisted over three fingers so as to form a loop. Round it at this point a piece of stout linen thread is tied, the ends being left free. The tampons are then sterilized in

the Arnold steam sterilizer or autoclave and kept in aseptic glass jars.

Tampons of absorbent cotton are made in very much the same way. The cotton, as it is taken from the roll, is cut into pieces measuring twenty by ten by two centimetres (eight by four inches by half an inch), and each piece being folded once, a piece of thread is attached to the loop, and the ends are rounded off with scissors. Plate XIII., Fig. 5.

Bandages are always being required, and a good

FIG. 19.

Modified Scultetus bandage.

supply made from gauze and flannel should be kept on hand. They should be of different widths, and, in order to insure straight margins, should be cut by

"drawn thread." Besides these, the ordinary T *bandage* and the modified *Scultetus bandage* (Fig. 19) should be always kept in stock. All bandages are to be sterilized in the way described above for dressings of the same material.

Instead of ordinary marine *sponges* we now employ substitutes made from sterilized gauze. The gauze employed for this purpose is the same as that used for dressings. Sponges may also be made by wrapping cotton somewhat loosely in squares of gauze, the corners being brought together and tied at the top with thread. (Fig. 20.) When employing gauze for sponges, the cut edges should be folded in and hemmed, or folded in so that no loose threads are left in the field of operation. Such sponges can be made of various sizes, and can be easily sterilized by means of steam heat immediately before the operation. Or a supply may be sterilized and kept in packages, or in a jar of a solution of bichloride of mercury (one to five hundred) till just before the operation, when they are to be removed from the solution and thoroughly rinsed in sterile water or in sterile salt solution. In buying marine sponges the cheap reef variety and those that are in the rough will serve every purpose. They generally arrive packed so

FIG. 20.

Sponge made of cotton and gauze.

tightly together as to form almost a solid mass. They should first be carefully separated, placed in a muslin bag, and well pounded, to remove all particles of sand and other foreign materials. They are then rinsed out in water several times. A very good way is to place them in a basin or pail and allow the water to run in upon them from a tap for several hours. They are next soaked in a saturated solution of permanganate of potassium, are afterwards decolorized in a solution of oxalic or of sulphuric acid, and are then left for twenty-four hours in an aqueous solution of hydrochloric acid, made strong enough to taste slightly sour. After this they are again soaked in water until the washings are clear. They are next placed in a bichloride solution (one to five hundred) for twelve hours, and finally are rinsed in warm water and preserved in covered glass jars containing a three-per-cent. aqueous solution of carbolic acid, the solution being changed every week. Plate XIII., Fig. 4. When required for use the sponges may be taken out, after the hands have been thoroughly sterilized, and dropped into a sterilized pitcher which contains sterilized water. The excess of carbolic acid is now squeezed out, the water being changed two or three times. The sponges are then placed in basins, which should contain sufficient sterile salt solution to cover them completely.

The gauze sponges are easily sterilized, and are so inexpensive that they need never be employed more than once, and consequently are far preferable to marine sponges. The latter, however, have the advan-

tage of being more elastic and pliable and are therefore more desirable for abdominal cases, and indeed in abdominal surgery are still preferred by many operators. Unfortunately, we cannot sterilize them by steam without ruining them. Although they are rather expensive, they should be thrown away after they have been used once, since the possibility of rendering them sterile after they have been covered with purulent and bloody substances is, to say the least, problematical. Schimmelbusch, in dealing with the sterilization of marine sponges, does not recommend boiling them in water or soda solution, for under such a procedure the sponges contract and become hard, but says that if, after being thoroughly cleansed, they be placed in a bag and immersed for half an hour in a one-per-cent. solution of soda (which has been boiled, and afterwards removed from the fire and allowed to cool to 85° or 90° C.), they will be quite sterile. The sponges, with care, will stand this treatment several times. As we have said, it is far better never to use them a second time; at any rate, sponges which have once been employed should never be admitted to an operation without being sterilized in this way.

CHAPTER VIII.

ASEPTIC DRAINAGE—GLASS AND RUBBER DRAINAGE-TUBES—GAUZE DRAINS—CARE OF RUBBER MATERIALS—RUBBER DAM—RUBBER TUBING—RUBBER GLOVES—AND ARMLETS.

Our ideas regarding the necessity for and the efficacy of drainage in abdominal surgery have undergone during the past few years the most radical changes. The time was when we did not close the wound of an abdominal section without inserting a large tube which reached well down among the tissues. It was then thought that infected cases—such, for instance, as pelvic abscesses—could never recover without drainage, and that even in the cleanest cases it was always well to insert the tube for at least a few hours until the so-called serous oozing had ceased, in order not to tax too severely the absorptive power of the peritoneum. Now that our attention has been called to the importance of taking more pains with the minute operative details, since we have recognized the necessity of checking all hemorrhage, even from the smaller bleeding points, of avoiding any infection of the field from the contents of abscesses or of the intestines, and of making a careful peritoneal toilette, above all, since we have understood the effects of any rough handling of the tissues, we have come to look upon the necessity for drainage as being the exception

rather than the rule. Whereas a few years ago nearly ninety per cent. of all cases were drained, now we drain only from ten to fifteen per cent., and indeed, from bacteriological examinations made in a large number of cases, it has been proved that, even under the most favorable conditions and with the personal attention of trained assistants, it is extremely difficult to prevent the access of pyogenic micro-organisms into the tube. We have pointed out that the presence of the white staphylococcus in the skin is a constant menace where the way to the wound is kept open by a tube, and it was found that the dressing of the drainage cases led almost invariably, after two or three times, to bacterial contamination. Whereas we used to be afraid to close the abdominal wound completely on account of the danger of sepsis, we now close it in every case possible, and rather hesitate, from fear of infection, to drain the abdomen. The objections to the insertion of drainage-tubes have been formulated recently by Dr. Welch* as follows:

"(1) They tend to remove bacteria which may have gotten into a wound from the bactericidal influence of the tissues and animal juices. (2) Bacteria may travel by continuous growth or in other ways down the sides of a drainage-tube, and so penetrate into a wound which they otherwise would not enter. We have repeatedly been able to demonstrate this mode of entrance into a wound of the white staphylococcus

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* Maryland Medical Journal, 1891.

found so commonly in the epidermis. The danger of leaving any part of the drainage-tube exposed to the air is too evident to require mention. (3) The changing of dressings necessitated by the presence of drainage-tubes increases in proportion to its frequency the chances of accidental infection. (4) The drainage-tube keeps asunder tissues which might otherwise immediately unite. (5) Its presence as a foreign body is an irritant and increases exudation. (6) The withdrawal of tubes left for any considerable time in wounds breaks up forming granulations,—a circumstance which both prolongs the process of repair and opens the way for infection. Granulation tissue is an obstacle to the invasion of pathogenic bacteria from the surface, as has been proven by experiment. (7) After the removal of the tube there is left a track prone to suppurate and often slow in healing." To these Professor Halsted has added an eighth,—viz., "Tissues which have been exposed to the drainage-tube are suffering from an insult which more or less impairs their vitality and hence their ability to destroy or inhibit micro-organisms."

When an abdominal wound became infected subsequently to an operation, it was formerly thought that this result was due to micro-organisms already present, it might be, in a pelvic abscess, or in the secretions about the uterine adnexa. Undoubtedly this mode of wound-infection may occur, but it should be remembered that in a very large proportion of the cases of pyosalpinx the pus is sterile, any organisms which

had before been present being dead. This has been proved many times by examination of smear cover-glass preparations and the study of cultures made at the time of the operation. Unless bacteriological examinations have been made of such secretions or accumulations of pus, it is impossible to feel sure that an infection which has followed the operation has come from within.

There are cases, however, in which drainage is still indispensable, and the surgeon has to decide upon the safest and best means of employing it.

Where tubes are employed, those made of glass, introduced by Köberlè, of Strasburg, with slight modifications, are the best, as they can be easily rendered sterile by being allowed to remain for an hour in a one to five-hundred bichloride solution. These tubes are straight, varying in length from twelve to fifteen centimetres (four and a half to six inches), and in diameter from eight to ten or twelve millimetres (three-tenths to half an inch). Tubes curved at the end are also valuable where it is necessary to drain Douglas's pouch over the convex surface of a tumor.

Every tube should be perforated with from nine to twelve holes, one millimetre (one twenty-fifth of an inch) in diameter, beginning from the inner end and extending for one-third the length of the tube. When the diameter of such holes is larger, portions of the omentum and of the small intestines are very apt to work through them into the lumen of the tube, and thus artificial strangulated herniæ may be formed.

The tube should be placed in such a position that it will carry off the fluid which accumulates in the most dependent portion of the pelvis. This is best accomplished by inserting it in the cul-de-sac of Douglas, so that the inner part lies just behind the uterus, gently resting on the floor of the pelvis, while the more external portion lies in the abdominal incision from four to eight centimetres (an inch and a half to three inches) above the symphysis pubis. Gauze carried through the posterior fornix into the peritoneal cavity will often give satisfactory drainage.

Capillary drainage can be obtained through the glass tube by means of a piece of wick, gauze, or cotton. If one of these substances be thoroughly sterilized and carefully placed in the tube, so that drainage can take place from the bottom, it will insure a steady capillary flow of fluid from the pelvis to the outside.

A drain made of ordinary lamp-wick thoroughly sterilized is the most efficient; next to this, narrow strips of gauze, twisted into rolls only large enough to enter the tube easily, are to be preferred. Plate XIII., Fig. 8.

Other means of draining the pelvis from above are employed. In some cases of wide-spread injury to the cellular tissue of the pelvis it is impossible to check the bleeding and drain satisfactorily by means of the glass tube alone. Under these circumstances it is often possible to effect both objects by packing long strips of a five-per-cent. iodoform gauze, three centimetres (one inch) in width, behind and on each side of the uterus, the ends being brought out at the lower

angle of the wound. Firmer pressure can be made and drainage secured by folding or coiling the gauze, as it is placed in the pelvis, in the form of a spiral, one end being brought out through a drainage-tube. The pressure on the tube, and through this on the gauze packed in the pelvis, can be regulated by tightening or loosening the abdominal binder.

A pack introduced in this way can be removed with very little disturbance by slightly raising the tube and pulling the gauze out through it layer by layer. There is thus no danger of drawing out intestines or omentum with the dressing.

If the tube be placed in a proper position, so that capillary drainage be provided for in some such way as we have described, there will not only be a continuous flow from the peritoneal cavity to the outside, but the tube will not need cleansing as frequently as has been generally thought necessary.

It is useless to remove the dressings every hour or two and expose the patient to the risk of a septic infection by repeatedly cleaning out the tube. A tube which has been put in properly can safely be left to care for itself for a period of from twelve to twenty-four hours, after which time it will be necessary to uncover it in order to remove the overlying dressings which have become saturated by the discharges.

In fifty cases thus drained, this point has been tested by allowing the tubes to remain undisturbed for from twenty-four to forty-eight hours, and in not one was a single unfavorable symptom observed.

The importance of perfect cleanliness in dressing the tube is not usually sufficiently appreciated. Hands, instruments, and dressings employed must be as thoroughly aseptic as at the time of the operation, if we wish to avoid the danger of introducing infection from without.

For the purpose of cleaning out the tube, the tube-forceps devised by Dr. Kelly has proved very valuable in facilitating rapid and cleanly work. Plate III., Fig. 2. The instrument is provided with two very slender tapering handles, crossing like scissors, the blades below being furnished with rat-teeth to hold the little ball of cotton which is to be carried down to the bottom of the tube. The blades are fastened by a new style of lock devised for the purpose, as shown in the cut.

A piece of sterilized cotton, sponge, or gauze small enough to pass easily down to the bottom of the tube is grasped in the forceps, gently guided down into the pelvis, and again withdrawn, bringing up with it the secretions, the process being repeated with a fresh pledget until the tube is dry.

This is generally the better method, but if there is much secretion, a small metal or glass syringe may be used with a small rubber catheter. These can be readily sterilized in boiling water.

It is necessary at each dressing, after cleaning the tube, to rotate it at least two or three times. It will sometimes be found, as we have said above, especially where the perforations are of somewhat large calibre,

that pieces of omentum as large as split peas have become firmly fixed in the holes in the tube, forming veritable omental herniæ. Sometimes all the holes on one side will thus be choked. If gentle rotation and traction fail to effect a release of the omentum, the tube must be carefully lifted up far enough to permit of a ligature being passed on the outside of it around each little hernial mass in turn; after the ligature has been tied the tube should be cut loose with a pair of delicate long-bladed scissors or with a slender knife. If the intestine should be caught in this way, it must be released by traction and careful pressure from the outside of the tube, made by means of a small piece of cotton or gauze in the grasp of the tube-forceps.

To decide how long the tube shall be left in the abdomen is in some cases a difficult matter. It must be borne in mind that the tube is inserted for the purpose of drainage, and that, its function being over, it should be removed as soon as the flow of fluid is not more than enough to wet the plug in it. This point may be reached in from twelve to twenty-four hours, or in some instances not until the fourth or fifth day. The early removal of the tube relieves the patient of discomfort and consequent mental anxiety; it also allows the fresh tissues in the track of the tube to come together, so that immediate union is promoted and the liability to ventral hernia at a later date is diminished.

If there is but a scanty flow of serum on the dressing about it, and the general condition of the patient

is good, the tube may be removed without fear, and any slight secretion left to the care of the peritoneum. If, on the other hand, the pulse and temperature are of such a character as to occasion anxiety, the pulse being 120 or more and the temperature over 100° F., although the discharge may be but slight, it is better not to remove the tube and close the wound until the flow has entirely ceased.

When the tube has been removed and a slight discharge still remains, we may keep the track open by inserting a piece of twisted gauze, which is changed once in twelve or twenty-four hours, a few grains of the iodoform and boric acid powder (one to seven) being dusted into the wound at each dressing. This procedure, while allowing the sinus to close up gradually, at the same time provides for the carrying off of any noxious fluids which would otherwise tend to accumulate. Where there exists a free purulent discharge from the first, the tube should not be removed until one or two weeks have passed, otherwise we are liable to have a formation of pockets of pus in the pelvis.

Another more gradual method of removing the tube may be employed when the discharge is rapidly diminishing and does not amount to more than a few teaspoonfuls in twenty-four hours. At each dressing the tube may be rotated and raised from one to two centimetres. Before its final removal the tube should be cleansed as thoroughly as possible and rotated to make sure that the intestines are free. The thumb is then placed over the end, and the tube, being grasped be-

tween the first and middle fingers, is slowly and gently removed. As soon as it is out, the wound is dried and the provisional sutures are drawn up, thus closing the track of the tube in the abdominal wall. The provisional sutures consist of one or two passed through both sides of the abdominal incision round the tube, and left loose until they are required for this purpose.

Drainage by means of the gauze bag also gives very good results. A pack made up of several strips of sterilized gauze is inserted into a long, narrow gauze bag and used as the tube; this causes a rapid removal of the fluid by capillary attraction. Plate XIII., Fig. 8.

Two useful canons in gynæcology are: (1) drain rarely and only when absolutely necessary, and (2) when employing drainage let it be thorough.

The rubber dam is also a useful adjunct to our stock of dressing materials. Where a glass tube is employed for the purpose of drainage after an abdominal section, it is convenient to have a strip of sterilized rubber dam twenty-four centimetres (ten inches) wide (of the same kind as that used by dentists or a little thicker) and long enough to extend from the symphysis pubis to the umbilicus. A slit is made down the middle of this, through which the top of the drainage-tube projects. After the gauze has been packed into the drainage-tube and the cotton placed immediately over it, the ends of the rubber dam are folded in over the cotton. Over this comes an additional layer of absorbent cotton, and a bandage is applied to cover the whole. The rubber dam thus holds the dressing immediately over the tube

in place and tends to prevent the penetration of any fluids beyond this limit. Since the rubber comes in such close contact with the wound and the abdominal cavity, it is, of course, very necessary that it should be thoroughly sterilized. To effect this it may be boiled for five minutes in a one-per-cent. soda solution and afterwards preserved in a glass jar containing a one to twenty aqueous solution of carbolic acid. When required for use it is removed from the jar with the necessary precautions, and then rinsed off in sterile warm water before being placed in position.

Rubber tubing, besides being used sometimes for drainage, is convenient for constricting the uterus while a myoma is being removed from it. It comes in several sizes and costs about twenty-five cents per metre. It can be sterilized in soda solution and kept till it is needed, in the same way as the rubber dam, in a stoppered glass bottle containing a five-per-cent. aqueous solution of carbolic acid. In order to make quite sure that it is perfectly sterile, it will perhaps be best to boil the piece about to be used in a one-per-cent. soda solution just before the operation. Rubber dam and rubber tubing should not be kept in solutions of sublimate, owing to the chemical action exerted upon them by this substance.

Rubber gloves and *armlets** should be more extensively used. It is probable that the chances of infection

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* These gloves may be bought of the Goodyear Rubber Co., New York.

would be very much diminished if the assistants were required to wear them at operations, since they can be rendered absolutely sterile, which is not necessarily true of the skin of the hands. Their use by the operator himself would also facilitate the performance of a great deal of minor work without any inconvenience resulting therefrom. If the gloves are worn after being sterilized by being boiled in a one-per-cent. soda solution, it will be necessary to scrub the hands and forearms only once or twice, and, as we have pointed out above, their use will often prevent contamination. (Chapter III.) Since the first edition of this book appeared I have become convinced that for any disadvantages connected with them the operator is more than compensated by the lessening of risk to his patient. They will stand sterilization in soda solution many times without injury. They come in different sizes, and it is best to wear a pair which fit the hands very loosely, in order to facilitate putting them on and off. Those with the long wristlets are the most serviceable, as they protect a considerable portion of the forearms. When putting the gloves on or taking them off, care should be exercised, on account of their delicate structure, not to handle them roughly. If one experiences any difficulty in getting them on, they can be filled with the solution contained in the vessel until the fingers of the glove become distended, after which they can be slipped on quite easily. The hand is then held up and the solution is allowed to run out. If they stick at all when one attempts to remove them, they should

be gently turned inside out. After the operations are over for the day, the gloves may be washed off thoroughly, hung up to dry, and afterwards put away, to be sterilized in soda solution immediately before the next operation.

CHAPTER IX.

FLUIDS FOR IRRIGATION—PLAIN STERILE WATER—ANTISEPTIC FLUIDS FOR IRRIGATION—STERILE PHYSIOLOGICAL SALT SOLUTION—ANTISEPTIC POWDERS—IODOFORMIZED OIL—BICHLORIDE CELLOIDIN—IODOFORMIZED CELLOIDIN—SILVER FOIL—GUTTA-PERCHA.

It is the custom of many surgeons to irrigate the abdominal cavity after almost every operation, while others use this method only in those cases where fluid has escaped into it during the removal of a tumor, or where the bleeding from the separated adhesions has been marked. The substances which have been used for this purpose are plain hot water, sterile salt solution, and a variety of so-called antiseptic solutions. The routine treatment of irrigating every case cannot now be considered a necessary practice. Where the structures are non-adherent and there have been no complications, there would seem to be no indication for its employment, but after the removal of a mass which contains bloody or purulent fluid, or where a great deal of oozing has occurred as a consequence of the separation of dense adhesions, irrigation may sometimes be useful. If the fluid that has escaped be of a septic nature, the advantage of irrigating the pelvic cavity under these circumstances has been disputed, and it is not unreasonable to suppose that when such material has escaped into the abdominal cavity,

attempts to remove it by irrigation might be apt to spread it farther about between the coils of the intestines and into parts of the abdominal cavity whence it would be impossible to remove it by any subsequent sponging. If solutions containing germicidal drugs are used for irrigating the abdominal cavity, there is not only the uncertainty that the drug may not prove of sufficient strength to destroy the septic material which remains, but there is also the danger of causing local lesions, as well as of subsequent results from the absorption of toxic chemical substances. Fortunately, in the majority of cases the fluid which is contained in old abscess cavities in the pelvis does not contain living organisms. This fact has been proved by cultural experiments, and explains why in these cases infection has not occurred, though pus has escaped at the time of the operation. When it happens that, through accident during the removal of an ovary for malignant disease, it ruptures and the contents of the tumor escape into the pelvic cavity, it is above all things necessary to remove the escaped particles of tumor material, so that the formation of metastases upon the peritoneal surface may be prevented.

In the past few years we have obtained excellent results in pus cases by free irrigation, in this way removing all the morbid material possible, the remainder being diluted by the fluid with which the abdominal cavity is filled after the irrigation has been completed.

In selecting a fluid for abdominal irrigation we naturally look for one that promises the best possible

results with the minimum possible amount of harm, and up to the present time none has proved more satisfactory than the warm sterile normal salt solution. Of its advantages and of the way of preparing it I shall speak in a few moments.

The fluid which has perhaps been most generally used is plain water. It can easily be rendered sterile by boiling it in a clean vessel just before the operation. It is well to have two vessels, one of sterilized water which has been allowed to cool, and the other containing water still hot. When required for irrigation, the water from the two vessels is mixed until the proper temperature is obtained (from 43° to 48° C. (110° to 118° F.)). The water should be in a perfectly clean pitcher or graduate, and from this it is poured into the abdominal cavity.

With plain sterile warm water we not only aim at cleansing the abdominal cavity but also at stimulating the circulation, and thus in a measure overcoming the tendency to shock. The principal objection to the use of plain water for irrigation is that it has a definite deleterious effect upon the tissues. It is a fact well known to microscopists that when fresh animal tissues are examined in plain water the cells are seriously altered and, as has been shown by repeated experiments, the red and white blood-corpuscles are injured or completely broken up by its action.

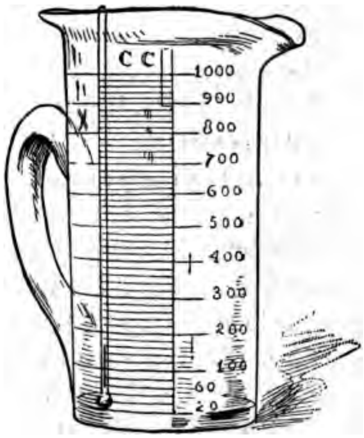
The use of solutions of sublimate and carbolic acid for irrigation of the peritoneal cavity must now be unhesitatingly condemned, both on account of the

local necrotic effects which are produced and because of the danger of general intoxication. The experiments which have been made with dilute solutions of sublimate upon the abdominal cavity of dogs are too well known to need any description here; and yet not a few abdominal surgeons long persisted in pouring this poison into the abdominal cavity, notwithstanding the fact that autopsies had proved that the patients sometimes died afterwards with intestinal ulceration and peritonitis, or with lesions of the heart and kidneys, of which there was no evidence before the operation. (See page 39.)

Of the milder antiseptic solutions, such as one-half- to two-per-cent. solutions of boric acid, Thiersch's solution of salicylic acid, and the like, it may be said that they possess no advantages over the simple solution of common salt. This is made to correspond in specific gravity very closely with the normal serum of the blood, whence the term "normal" or "physiological" salt solution. It is prepared by dissolving six grammes (ʒiss) of sodium chloride in each litre ($33\frac{1}{2}$ ounces) of distilled water. This solution is filtered into a clean flask which may hold about three litres. Plate XIV., Fig. 1. The flask is plugged with non-absorbent cotton, the top of the plug being securely wrapped in a gauze bandage in order to prevent the deposition of dust on the rim of the flask. After being heated over a Bunsen flame until the fluid boils, it is immediately transferred to an Arnold steam sterilizer, already heated to 100° C., and allowed to remain there for half an hour. The process

is repeated on the two following days. The fluid is to be used at a temperature of 43° C. (110° F.) or as high as 48° C. (118° F.). It can be made up in quantities of one dozen flasks or more, and kept all ready for use. When required for use, two flasks are taken, one containing cold and the other hot solution, and their contents mixed in a sterile glass graduate to which a thermometer is attached, and which holds from five hundred to one thousand cubic centimetres. (Fig. 21.) This jar must, of course, have been ren-

FIG. 21.



Thermometer jar. (Robb.)

dered perfectly sterile in the same way as the glass trays for the instruments. The gauze and plug having been removed with due precautions, the cold salt solution is first poured into the thermometer jar and then enough of the hot solution is added to

PLATE XIV.

FIG. 1.—Sterile salt solution in flasks.

FIG. 2.—Glass jar containing irrigating fluid, with tube and nozzle attached.

raise it to the proper temperature. The thermometer affords the best means of testing the temperature of the water, and the hand of the assistant or nurse should not be relied upon. Such loose determinations are inaccurate, and, what is more important still, the hands may contaminate the fluid. This is a detail of importance, and the careful observance of it should be insisted upon.

The solution is poured into the abdominal cavity directly from the glass graduate, or it can be siphoned through a glass or hard-rubber nozzle attached to a piece of rubber tubing; or if preferred a new Davidson syringe, previously sterilized in boiling soda solution, with a glass nozzle attached, may be employed. The Davidson syringe suitable for this purpose can be bought without the usual attachments for the irrigating end, and so be less expensive. The glass nozzle can be readily attached to the end of the tube, and its lumen, being so much larger than that of the ordinary nozzles which come with these syringes, will permit a much larger flow through it, and besides can also be much more easily sterilized. (Fig. 22.)

In performing plastic operations, irrigation is not only very necessary, but its use dispenses with the necessity of sponging. A constant stream can be employed and be so regulated as to keep the field of operation free from the blood that would otherwise obscure it and hamper the operator. The fluids used for this purpose are either warm sterile water or, better still, sterilized normal salt solution. The solu-

tion is placed in a sterile glass jar (Plate XIV., Fig. 2) fitted with a piece of rubber tubing which is provided with a glass or hard rubber syringe stopcock by which the current is controlled. The handy little apparatus devised by Edebohls, of New York, can be readily sterilized and will prove eminently satisfactory. Instead of a glass jar, a rubber bag large enough to contain two litres may be used. Such rubber bags are sold under the name of fountain syringes, and are to be rendered sterile in the manner described for other rubber materials.

Fig. 22.

Glass douche-nozzle.

The *powders* most frequently employed in surgery consist of iodoform and boric acid, either alone or in combination. The iodoform, when used alone, should be well rubbed up, as it is very apt to become lumpy, and it should be lightly dusted over the surface of the wound. Iodoform, perhaps, is the best germicidal powder that we have. Boric acid is frequently employed in the same manner as iodoform. The chief objection to using powders at all is that, while the substances may, perhaps, preserve their germicidal power when in solution, it is difficult to have them perfectly sterile when in the

form of dry powder. Iodoform and boric acid (one part of the former to seven parts of the latter) placed in ignition tubes and sterilized in the autoclave afford a valuable mixture, and one often employed, since the powder possesses the advantage of being non-irritating. After an operation it is well to dust this powder just along the line of the incision or on the gauze which protects it. After an abdominal section, when we wish to close the wound immediately, we protect it first with the occlusive dressing shortly to be described, and then incorporate the iodoform and boric powder in the celloidin after it has been poured over the gauze. In plastic cases we dust the powder well over the field of operation, and also use a small quantity of it each time after catheterizing the patient, the powder being dusted over the field of operation and the external genitalia.

Some patients are extremely susceptible to the toxic effects of iodoform, even when very small quantities are employed. Under these circumstances we can use either the boric powder alone or a powder composed of one part of subiodide of bismuth to seven parts of boric acid. The powders should be kept in sterilized glass vessels, and when they are to be applied to a wound should be shaken from a special flask that has first been sterilized. Such a powder-box can be cheaply and easily made by covering the mouth of a bottle made of glass or metal with a piece of wire screen. The meshes should not be too coarse, or the powder will escape too freely. (Fig. 23.)

On account of the danger of poisoning by iodoform, salol has been recommended as a substitute for it.

FIG. 23.

Aseptic powder-flask. (Robb.)

Iodoformized oil, which is a combination of oil and iodoform powder, often employed locally, can be mixed according to the following recipe. The oil (olive oil or oil of sweet almonds) is sterilized in a flask, plugged with cotton, for an hour on three successive days, and iodoform powder in the proportion of one part to four parts of oil is added just before the preparation is to be

used. In making this combination it will be necessary to use a sterilized glass rod and dish, and in order to insure asepsis, Böhm has suggested that the iodoform powder should be first carefully washed in an aqueous solution of sublimate and afterwards dried.

Occlusive dressings are frequently used to protect wounds. The solution which is perhaps most often used for this purpose in abdominal cases is that known as *bichloride celloidin.* The advantages of such a dressing, as has already been stated, lie in the fact that it not only protects the wound from infection from without, but will remain in place for a considerable length of time, and in a measure acts as a splint, allowing of a certain amount of movement on the part of the patient without any disturbance of the wound.

Bichloride celloidin (one to sixteen thousand) may be made according to the following formula:

℞ Ether (Squibb's),
Absolute alcohol, āā 200 cubic centimetres (6½ ounces);
Of a solution made of one gramme (15 grains) of bichloride crystals dissolved in 40 cubic centimetres (10 drachms) of absolute alcohol, 1 cubic centimetre (16 minims).

Mix and add of Anthony's "Snowy Cotton" enough to give the solution the consistence of simple syrup.

To the skin of some patients the bichloride in this strength will act as an irritant, and in such cases it is better to use a similar preparation of the strength of one to thirty-two thousand.

The occlusive dressing is simple and gives satisfactory results. The method of procedure is some-

what as follows. After the wound has been closed and the skin in the line of the incision and the sutures have been dried, they are covered with a piece of sterile cheese-cloth. This is fixed in its place by being saturated with the celloidin mixture, which can be evenly distributed over the surface of the gauze with a sterilized glass spatula. Over it is dusted some of the mixture of iodoform and boric acid powder (one to seven). A second piece of gauze considerably larger than the first is next applied, over which more celloidin is poured and more of the powder of iodoform and boric acid is dusted on. The dressing soon becomes dry and fixed. Over all is placed a mass of sterilized absorbent cotton, which is held in place by a binder. A wound which has been covered with this dressing may be left for a week or more if everything goes well. When the dressing is to be removed, it should be well softened either with warm sterile water or with a one to forty aqueous solution of carbolic acid applied on lint or cotton. This should be allowed to remain over the dressing for an hour or so before any attempt at removal is made, but, if necessary, the dressing may be loosened in a few minutes by pouring ether over it.

Iodoformized celloidin may be used in the same manner as the bichloride celloidin. It is made as follows:

℞ Absolute alcohol, 200 cubic centimetres (6½ ounces);
Iodoform powder, 50 grammes (12½ drachms);
Mix and add ether, 200 cubic centimetres (6½ ounces).

Mix and add of Anthony's "Snowy Cotton" enough to give the solution the consistence of simple syrup.

When making any of these celloidin mixtures, absolutely dry graduates and bottles must be used. These may be obtained by first rinsing them out with absolute alcohol, then with pure ether, the latter being then allowed to evaporate. In the preparation there must be as little exposure to the air as possible. The "snowy cotton" is to be added in small pieces and the bottle well shaken after each addition. Wide-mouthed flasks are the most convenient for the purpose.

Silver foil is used by some surgeons as an occlusive dressing. It is procured in tissue-paper booklets, each containing two dozen sheets. For sterilization, after the bound edge is cut off, the booklet is placed between two boards (quarter-inch poplar or white-wood boards are used, as these do not warp), wrapped up in muslin, and sterilized with the other dressings. The sheets are picked up on gauze wet with alcohol, and placed over the incision, which has been thoroughly dried. Over this the ordinary dressings are placed.

Gutta-percha tissue is sometimes used.

CHAPTER X.

ON CERTAIN PROCEDURES SOMETIMES NECESSARY BEFORE AND AFTER OPERATIONS, WHICH MUST BE CONDUCTED ASEPTICALLY — HYPODERMIC INJECTIONS — EXPLORATORY PUNCTURES — CATHETERIZATION—BLADDER-WASHING—URETERAL CATHETERIZATION.

Of the ordinary precautions to be taken in choosing a site for a hypodermic injection and of the anatomical structures to be avoided, it is not necessary to speak here. These points have been fully treated of in other works, and, as a rule, the suggestions made therein are carefully noted and acted upon. Unfortunately, hitherto sufficient attention has not been paid to the need of aseptic methods in making the ordinary hypodermic puncture, and it is a very common occurrence for even a good physician to take a hypodermic syringe from its case, dissolve a tablet in water, immediately fill the syringe, and at once plunge the needle into the subcutaneous tissues. It is more than probable that the risk of puncturing a vein, of injecting the periosteum, and the like, is no greater than is the danger of setting up an infectious process, so that one of the most important points to be attended to is that the puncture be made aseptically. That the danger of sepsis is by no means merely hypothetical is evidenced by the large number of cases of hypodermic puncture which have

been followed by abscess formation or localized phlegmons, and we have only to refer to the careful monograph of Fraenkel, of Hamburg, on gas phlegmons, in which he reports two cases of fatal spreading gangrene following hypodermic puncture, to illustrate further the danger which lurks beneath this ordinarily simple operation. The importance of sterilizing the hypodermic syringe after using it upon one patient before employing it again is shown by the cases on record in which erysipelas, anthrax, and tuberculosis have actually been transmitted through the medium of the hypodermic syringe. The sources of infection to be particularly remembered in giving hypodermic injections are the following: (1) the syringe and its needles, (2) the fluids to be injected, (3) the skin of the patient, (4) the hands of the operator. Although the dangers of an infection from the two last-named sources are not very great, yet the careful surgeon will disinfect both his own hands and the skin of his patient before introducing the hypodermic needle. Fortunately, solutions of drugs, such as quinine, antipyrin, and apomorphine, sometimes used for hypodermic injections, possess a certain amount of antiseptic power which tends to prevent the development and multiplication of pyogenic bacteria in them. On the other hand, solutions of the drugs in most common use, such as atropine, morphine, cocaine, and ergotine, favor the development of bacteria, and when kept too long, or if made without proper precautions, are frequently found to be swarming with micro-organisms, with the result that not only

are their medical properties sometimes impaired, but thousands of micro-organisms may be placed in the subcutaneous tissues; and even though the greater number of them may be harmless, at other times there may be pyogenic bacteria present which will give rise to the formation of local abscesses which are likely to prove very troublesome and even dangerous to life.

Fluids used for hypodermic injections should be sterile. When hypodermic injections of a drug are given only rarely, it is best to make up a fresh solution each time. In private practice, where the tablets are so much used, a very simple expedient enables us to make a practically sterile solution at a few minutes' notice. A dessertspoonful of water is held over a lamp until the water boils. A tablet is then allowed to roll from its phial into the spoon. This immediately dissolves and we have a practically sterile solution. Of course, where the drug is one which is injured by a temperature of 100° C. (212° F.), the best we can do is to have the water boiled and allowed to cool somewhat before the tablet is placed in it.

Even in hospitals, where stock hypodermic solutions must be kept in the operating-room, it is best not to make too large a quantity at once. In the case of the majority of solutions which have been prepared aseptically, the addition of from two to three drops of pure carbolic acid to thirty cubic centimetres (1 ounce) of the solution will prevent the development of bacteria and at the same time will not be sufficient to do any

injury. Cocaine may be dissolved in various menstrua, but keeps best in a one to ten-thousand solution of corrosive sublimate.

The sterilization of hypodermic syringes has been and is still a difficult problem: the complexity of the instrument, and especially the inaccessibility of the piston, render it by no means easy to free from germs. The ingenious syringe of Koch has no piston and is easily sterilized, but it is too inconvenient for practical use, and the many improvements suggested have as yet failed to give us a satisfactory instrument. The syringes made entirely of glass with asbestos pistons, if they are well made, are very satisfactory for a time, but the asbestos piston soon gets out of order. The piston should be withdrawn from the barrel and both placed in a five-per-cent. solution of carbolic acid, which will render them sterile. Just before the syringe is used sterile water is drawn through it. Metal syringes as well as the needles can be boiled in a one-per-cent. soda solution. Hypodermic needles made of platinum can be rendered perfectly sterile by heating them in the flame of a Bunsen burner or of an alcohol lamp, but exposure of the ordinary needles to the flame soon ruins them.

Exploratory puncture and paracentesis are not so frequently resorted to as in former days, chiefly because radical operations with our present methods are now not accompanied by much greater risks. It is still occasionally necessary, however, to draw off the fluid from the chest or the abdomen in cases of pleurisy, ascites,

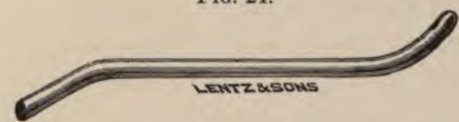
or in other conditions, either for purposes of diagnosis or for the relief of the patient. The needle, trocar, or rubber tubes used should be sterilized in a one-per-cent. soda solution, and the skin of the patient as well as the hands of the operator prepared according to the principles already laid down.

Catheterization of the female bladder is so simple a procedure that it seems almost superfluous to do more than mention it in a book on surgical technique. But, although so simple, there is probably no operation which is so often done improperly, and the nurse or physician has been responsible over and over again, through oversight or carelessness, for the setting up of a serious infection of the bladder, or even of fatal suppuration in the kidneys or their pelves. The normal urine is probably always sterile, bacteria being discharged through the kidney only when there are lesions in the renal parenchyma. In the majority of the cases of infection of the urinary passages the pathogenic bacteria have gained entrance from below. It is interesting to note, too, that one of the most frequent micro-organisms associated with cystitis, pyelitis, and pyelonephritis is a bacterium indistinguishable by laboratory methods from the bacillus coli communis. The staphylococcus, streptococcus, and proteus vulgaris are also sometimes present in cases of cystitis. These facts should teach us the importance of thoroughly cleansing the external parts before we undertake the catheterization of the bladder. The physician should not only always take care himself, but also instruct

the nurse to make sure that no possible precaution for the prevention of infection is neglected.

For catheterization the patient lies in the dorsal position with the knees somewhat separated. A sheet or blanket is thrown over the thighs and reaches down to the knees, leaving the vulva exposed. "Catheterization in the dark" is no longer justifiable. The labia are held apart with a gauze sponge, and the meatus urinarius and the parts around it are thoroughly cleansed with a cotton sponge and warm boric solution before the catheter is inserted. One great difficulty in the way of an aseptic catheterization of the male has lain in the impossibility of sterilizing the gum-elastic catheters, which are still often used, without at the same time injuring them. Fortunately, in the female this difficulty has been obviated by the introduction of the simple glass catheter (Fig. 24), which

FIG. 24.

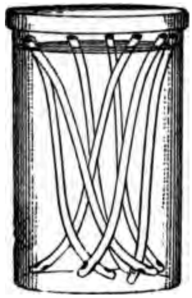


Glass catheter.

is easily rendered sterile by being well scrubbed with soap and water and afterwards being placed in a five-per-cent. solution of carbolic acid for five minutes. A number of them may be cleansed at the same time, if desired, and kept in a one to twenty solution of carbolic acid. (Fig. 25.) Whenever one is needed, it is removed from the jar and placed in a basin containing

a warm boric acid solution. If by chance a glass catheter is not available, rubber or silver catheters may be employed after having been boiled in the one-per-cent. soda solution. For a lubricant, sterilized oil or glycerin may be used. If the glass catheter be used no lubricant is necessary. It has been suggested that the urethra should be washed out carefully with some sterile fluid before catheterization, inasmuch as this takes away a certain number of bacteria. In the female it has been shown that the chances of contamination from the urethra, in the absence of a definite urethritis, are very slight.

FIG. 25.



Glass catheters in one to twenty carbolic acid solution.

After a catheter has once been used it should be thoroughly cleansed before it is put away; and here mechanical means are of great importance. The outside should be scrubbed with brush and soap, and hot water or soda solution should be syringed through it until the lumen is thoroughly clean. The catheter is then placed in a jar containing a one to twenty solution of carbolic acid until again required for use.

Irrigation of the bladder is often indicated, and for this purpose a sterilized solution of boric acid or normal salt solution is generally used. The warm solution is filtered into a sterilized rubber bag or fountain syringe, the end of the conduit tube from the bag

being attached to the end of the sterilized catheter, and, after the urine has been drawn off, is allowed to run slowly into the bladder, the stream being controlled by a pinch-cock placed on the tube. The tube is disconnected from the end of the catheter after about two hundred cubic centimetres have run in, or sooner if the patient complains of pain, and the bladder allowed to empty itself. The process may be repeated two or three times, until the washings are clear. If desired, a two-way catheter may be employed, especially if the distention of the bladder is at all painful.

A very simple and convenient apparatus consists of a glass funnel with rubber tubing connecting to a glass catheter. The articles can be sterilized by boiling in a one-per-cent. soda solution. After the urine has been drawn off, the air is expelled from the tube by allowing a small amount of the solution to pass through it; the catheter is then introduced into the bladder for a distance of four centimetres, the solution is slowly poured into the funnel, and passes into the bladder, which is slowly distended. The funnel is then inverted below the edge of the table and the fluid is siphoned out. This procedure is repeated several times.

Catheterization of the ureters will be described in detail elsewhere. It is necessary here simply to mention that the instruments, the hands of the operator, and the external genitalia are disinfected thoroughly according to the methods already described.

CHAPTER XI.

THE GYNÆCOLOGICAL OPERATING-ROOM—OPERATING-TABLE—INSTRUMENT-CASES AND OTHER FURNISHINGS.

ONLY in a hospital can we expect to have an ideal operating-room; at times we must content ourselves with a room fitted up at the patient's house, but this is at the best but a poor substitute.

The operating-room in a hospital should, while being within a convenient distance of the wards, be so located that the patients in them will not be disturbed by any of the unavoidable noises belonging to it, nor be annoyed by the smell of the fumes of the anæsthetic. There should be good-sized windows at the sides and in the roof, so arranged that most of the light comes from the north. It will be of advantage to have several smaller rooms adjoining the operating-room,—a dressing-room for the operator and his assistants, a store-room for supplies, a room in which the anæsthetic is administered, and another in which the patients may remain, if necessary, until they have had time to recover somewhat from its effects. A water-closet with bath-room attached should be near at hand, and a photographic dark room with water-supply is a great convenience, as it is often desirable to make photographs of unusual conditions upon the spot while the operation is in progress. These smaller rooms may be arranged on either side of the corridor at the end of

which the operating-room is situated, the room where the patient is anæsthetized being provided with a second door which communicates directly with the operating-room. The corridor can, if it be absolutely necessary, be also used as a waiting-room. If only two rooms are available, the one most favorably located as regards the distribution of the light and the water-supply should be employed as the operating-room, while the second room is used for a supply-room, in which the anæsthetic can also be given.

The operating-room of a general hospital should be sufficiently large to satisfy all requirements, especially those which will facilitate the efforts for the maintenance of an aseptic technique. One measuring twenty-six feet nine inches by twenty-five feet eight inches, or eighteen feet by twenty-six feet six inches, will answer every purpose where the number of operations does not exceed three or four daily. Everything about the room should be as simple and plain as possible and of such material and shape as will admit of a thorough mechanical cleansing and bear repeated washings with hot soda solution. The floor should be tiled or made of hard wood which has been paraffined, or white marble Mosaic in three-quarter-inch cubes, embedded in cement and polished, answers every purpose. The walls and ceiling are best plastered with King's cement, which should be coated with white enamel paint. The corners of the room should be rounded, in order to do away with crevices and nooks from which dust will be hard to remove. The walls and floor can thus be scrubbed whenever necessary without injury. Plate

XV. There should be arrangements for a good supply of light for operations by night or on dark days. The electric light will be found most convenient. A movable incandescent lamp with reflector is very useful for throwing a light directly into the abdomen during an abdominal section, especially where it is desired to find small bleeding-points. (Fig. 26.) A gas supply and

FIG. 26.

Edison storage-battery lamp with a McCreary half-shade.

fittings for the Bunsen burners are necessary. The room should be heated by the general heating apparatus of the hospital, but where it can be obtained, an open fireplace in addition will be of value. The temperature, which should be about 80° F., should be carefully regulated, a thermometer being always kept suspended in the room.

The operating-table may either be of wood, or have a glass top supported by legs made of metal. It can be made of quartered oak finished in paraffin, and both the top and legs should be perfectly plain, in order that they can be easily and thoroughly cleaned. A table forty-four inches (112 centimetres) long, twenty-one inches (54 centimetres) wide, and thirty-one inches (80 centimetres) high will be of a convenient size. It is well

to have the two legs at one end provided with rubber casters, so that while standing firm with the two ends level at other times, the table can be easily wheeled in any direction desired. The top is made of one-inch oak with rounded edges. There should be no grooves in which dust or foreign material may lodge. For an abdominal section a chair should be placed at the lower end of the table at such an angle that the top of the back will be caught beneath the lower edge of the table, so that the patient's feet rest upon the chair during the operation. When performing a plastic operation, the operator sits astride of this chair. The

Fig. 27.

Dr. Kelly's operating-table.

table devised by Dr. Kelly is very complete and can be used for any kind of operation. (Fig. 27.) It is thirty-two inches high, twenty-one inches wide, and

forty-four inches long. The objection to such a table is that it is expensive and requires a considerable amount of time to keep it clean. The surgical table devised by Dr. Halsted can be employed for abdominal and plastic work as well as for ordinary surgical operations. (Figs. 28 and 29.) This table is

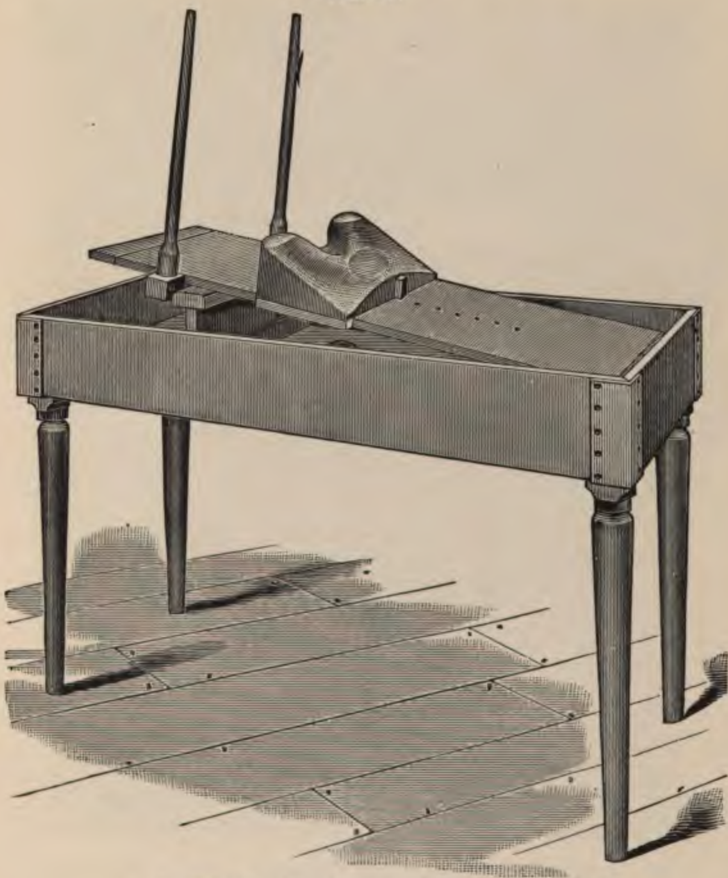
FIG. 28.

Dr. Halsted's operating-table.

in reality a shallow wooden sink supported by four legs, the sink being twenty-four centimetres (9½ inches) wider and forty centimetres (15½ inches) shorter than

the board of the stretcher, shortly to be described,

FIG. 29.

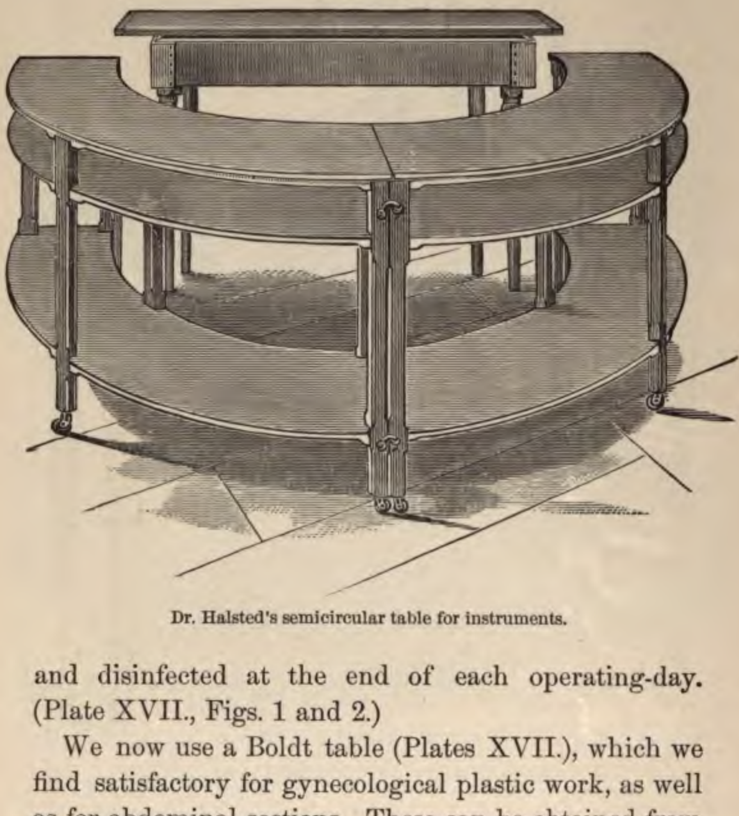


Dr. Halsted's table, showing perineal block in position.

which is placed upon it. By shifting the board the spaces at the side which serve as gutters can at any

moment be made as wide as desired. The floor of the sink drains to a hole in the centre, beneath which is placed a large galvanized iron can for the reception of fluids and waste materials. This should be emptied

FIG. 30.



Dr. Halsted's semicircular table for instruments.

and disinfected at the end of each operating-day. (Plate XVII., Figs. 1 and 2.)

We now use a Boldt table (Plates XVII.), which we find satisfactory for gynecological plastic work, as well as for abdominal sections. These can be obtained from Kny & Co., New York.

PLATE XV.

Gynæcological operating-room, Lakeside Hospital, Cleveland, Ohio.

PLATE XVI.

FIG. 1.—Modified operating-table for abdominal section. (Robb.)

FIG. 2.—Modified operating-table for plastic operation. (Robb.)

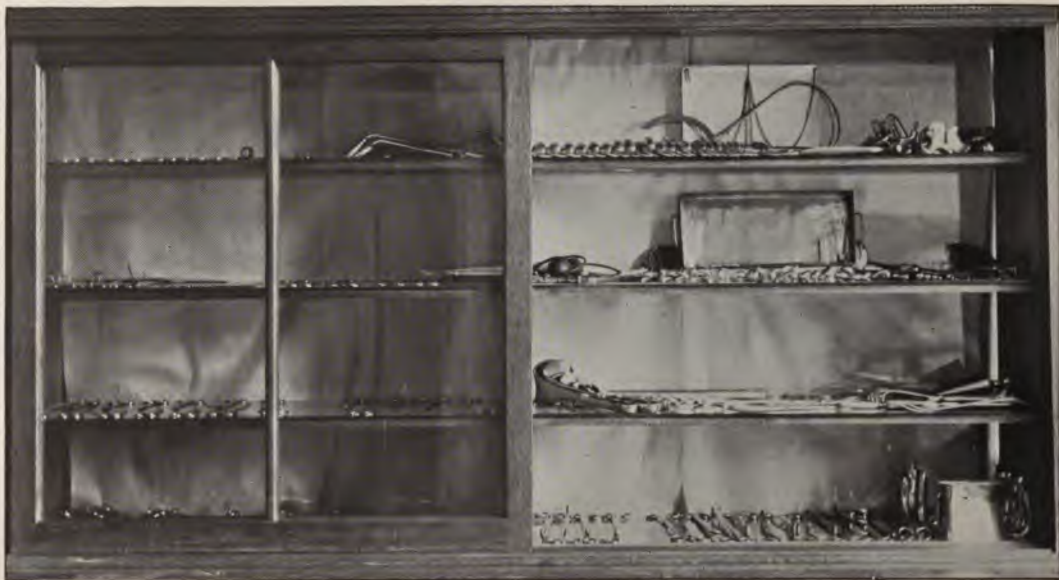
PLATE XVII.

Modified operating-table, Trendelenburg position. (Robb.)

PLATE XVIII.

Glass-top table with metal supports, for instruments and basins.

PLATE XIX.



Instrument-case.

PLATE XX.

Instrument case, showing sliding glass-covered shelf.

PLATE XXI.

Fig. 1.—Hæmostatic forceps strung on steel ring.

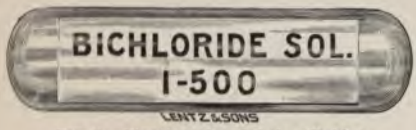


Fig. 2.—Floating glass label. (Robb.)

Fig. 3.—Glass basins.

Fig. 4.—Cotton pledgets in glass bottles.

Fig. 5.—Agate-ware vessel with top protected with gauze.

Tables for holding the basins or glass vessels may be made of the same kind of wood as the operating-table, or they may be made of metal supports with glass tops. Plate XVIII. They should be on casters, which will allow of their position being changed as often as is desired. The semicircular table devised by Dr. Halsted is convenient, as it will hold the vessels containing the instruments and dressings, while at the same time it hedges off the operator and his assistants from the bystanders. (Fig. 30.) One or two receptacles (made of iron or wire, which can be easily sterilized) for soiled dressings and sponges should be placed in the operating-room.

An instrument-case, constructed somewhat like a book-case, for holding the instruments when not in use is a very necessary piece of furniture. It should be simply constructed, so as to permit of being easily and thoroughly cleaned. Those made of plain quartered oak are the most satisfactory. The wood should not be thick, and the shelves should be perfectly plain, without trimmings. The shelves are best made of light wood covered on the upper surface with a thin piece of glass, or they may consist entirely of wood or glass. They should be so arranged that any one of them can be pulled out separately, and the instruments be thus exposed without the necessity of touching them with the hands. Plates XIX., XX. The instrument-case should be large enough to hold all the necessary instruments, and no cupboard should be placed beneath

it, as it will render the case more difficult to clean and also increase the risk of contamination. It should have casters attached to it, so that its position can be changed as often as it is necessary to clean the floor beneath it.

A good water-supply and conveniences for the disinfection of the hands are necessities in every operating-room, and an abundance of hot and cold water must be always at hand. Arranged on one side of the room there should be several marble basins, in order that the water may be changed rapidly and as frequently as is necessary. One or two large sinks will be necessary for cleansing the instruments and vessels between operations, and these should contain the solution in which the glass dishes are immersed before a second operation. It will be better to have the basins with the attachments freely exposed, so that they can be easily kept clean. The glass vessels in which the hands are rinsed off during the operation should be placed on a small table close to the operator, and should contain either warm sterile water or salt solution. Plate XXI., Fig. 3. If glass basins are not obtainable, those lined with porcelain will serve every purpose.

A table for holding the glass jars and glass dishes when not in use should occupy one of the corners of the room. It may be made of the same kind of wood as the instrument-case, and should be of the simplest possible construction.

The *sterilizers* for filtered hot and cold water can be arranged at one end of the room, with the special enamelled pitchers belonging to them.

Stretchers upon which patients are moved from place to place in the hospital are of many kinds. The one which we have found to be most satisfactory is 168 cm. (66 inches) long, 56 cm. (22 inches) wide, and 87 cm. (34 inches) high. It may have either two wheels and two legs or four wheels. In any case the wheels should have rubber tires. The top should be detachable, that the patient may be carried about on it if desired.

The operating-room of a private hospital can be arranged in very much the same manner as that belonging to a general hospital, but, of course, everything will be on a much smaller scale. So large a room will not be needed, as it will not be necessary to allow more space than that which is actually required for the fittings of the room and for those engaged in the work. The convenience of spectators will not have to be taken into consideration. The room should be situated in one of the upper stories, as far distant as possible from the other rooms of the house. One at the back of the house with a northern exposure, containing as many windows as possible, will be preferable on account of the light, and it will be a decided advantage if it have a skylight, which not only will give us light from above, but also can be opened after an operation and thus afford speedy and thorough ventilation. Two smaller rooms are better than a single large room, as a great many things which should not be in the operating-room itself may be kept in the second room, which can communicate with it by a door-way which

need have no door. The walls of the room should be painted with white enamel paint, as this can be washed without injury. The floor may be covered with linoleum, and this should extend up the walls of the room for one or two feet. The floor can then be thoroughly scrubbed without injuring either it or the ceiling of the room below. The fittings of the room should approximate as nearly as possible to those described for a large operating-room. The support for obtaining the Trendelenburg position can be obtained by the employment of the apparatus devised by Dr. George McKelway, of Philadelphia. The basins in which the hands are washed and sterilized should be conveniently situated.

In order to have as much space as possible in the operating-room the doors should be made to open towards the outside. The same care is to be exercised in the cleansing of the room as with the operating-room in a general hospital, and once a week, as a matter of routine, it will be advisable to thoroughly scour the walls and the entire furniture.

It is possible to arrange a small private operating-room at comparatively little cost. Time was when both operator and patient avoided hospital operating-rooms, as they seemed to be hot-beds of infection. Now, a surgeon will never operate, if he can avoid it, outside of his own well-regulated operating-room. However, even with the utmost care infection will sometimes occur, and too often a series of cases in which suppuration follows the operation are still met with. In

such instances the whole paraphernalia of the operating-room, including instruments, furniture, ligatures, sutures, and dressings, are to be thoroughly overhauled and resterilized. There has been some fault in the technique, and, as all the good boys in the school suffer for one bad one, so everything in the operating-room must be resterilized in order that the one source of danger may not be passed over.

CHAPTER XII.

THE ORGANIZATION OF OPERATIONS—THE MAINTENANCE OF AN ASEPTIC TECHNIQUE DURING OPERATIONS.

Now that we have completed the description of the preparation of the different materials which come into play in our operative technique, it may be well to describe briefly the method of properly organizing operations, whether major or minor, and to show how, after starting into surgical work with an aseptic field, sterilized instruments, hands, and dressings, the aseptic condition is to be maintained.

In order to do the best work, the surgeon should surround himself with a sufficient number of well-trained assistants and nurses, and keep them with him for some time, until they have become used to his particular methods of working. No matter how well trained the individual members of the corps may be, the whole cannot move satisfactorily unless all have worked together long enough for each to have learned his own particular duties and the precise relation of his own actions to those of others about him, so that his attention may never be distracted. To borrow an expression from the foot-ball field, it is essential that the operator and his assistants shall do "good team work." It is necessary, therefore, in starting in to do regular operative work in hospitals, large or small, that the surgeon

shall clearly define the exact duties of those about him. It is important that this shall be done at the start, and then, as experience in the course of time teaches, as it always does, that improvements in methods and in the distribution of duties can be made with advantage, the necessary changes may gradually be introduced. When a systematic routine has been once established, surgical work becomes a pleasure, and any operation can be done with but very few hitches and with a minimum of trouble. A surgeon who has accustomed himself to this orderly method of procedure will naturally avoid operations outside of his own operating-room, but will, nevertheless, in case the necessity arises, be the better prepared for conducting operations in private houses, or in other places where the dangers of breaking the technique become great. (Chapter XIV.)

We shall proceed to describe, therefore, as a type, the order of events in an ordinary abdominal section, undertaken—let us say, for the removal of an ovarian cyst, of adherent adnexa, or for a hysterectomy—in a well-conducted operating-room. We shall suppose that the patient is a young and strong woman, of good constitution, in fair condition for operation, who has been under observation for some days, parts of which have been spent in bed, in order to accustom her to the recumbent position which will have to be maintained for a few days following the operation. She has had a general bath besides two antiseptic vaginal douches each day. A specimen of urine taken by the catheter has been carefully examined and has been found to

show no striking abnormalities. During this preliminary surveillance the diet has been limited to soft, easily-digested food, and the bowels have been kept freely opened. If abdominal hysterectomy is to be performed, especial attention must be paid during these days to the cleanliness of the vagina and cervix, inasmuch as after removal of the uterus the dangers of infection of the peritoneal cavity from below are very great. The vagina in such cases must be repeatedly cleansed with soap and water and the douches be more frequent and thorough. Attempts to disinfect the cervical canal and the cavity of the uterus are perhaps in some cases justifiable.*

The operation is to be done sharply at 9 A.M., an excellent operating hour in a hospital. The day before the operation the patient's abdomen has been prepared in the way directed in Chapter IV., special attention having been given to the cleansing of the folds round the umbilicus. On the evening preceding the operation a purgative has been administered, followed by an enema in the morning. The bladder has just been emptied by catheter, and the vagina, rectum, and ex-

* One thorough method of doing this is to curette the internal surface of the uterus and cervix several days before the operation, and after curettement go gently over the surface of the uterine mucosa with the small point of the Paquelin cautery, packing the uterine cavity immediately afterwards with a strip of ten-per-cent. iodoformized gauze. The vagina is thoroughly douched twice daily and loosely packed with strips of iodoform gauze. Such radical measures are, however, only rarely to be adopted even in cases where the uterus is to be removed at the operation.

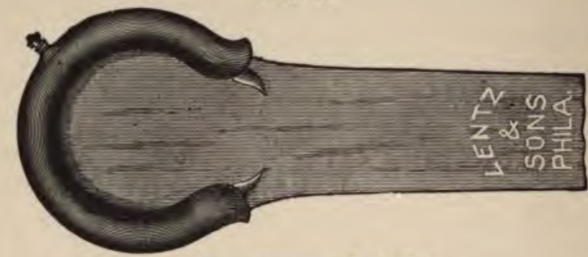
ternal genitalia have received a final thorough washing. Nothing has been given by mouth since midnight. The patient, attired in a fresh night-gown, flannel undervest, stockings, and warm wrapper, is now taken from the ward to the operating-room on a stretcher, where she should arrive at least half an hour before the time set for the operation. She is put to bed in a small room adjoining the operating-room, where an anæsthetic will be given by one of the assistant surgeons.

In the mean time the nurse has been doing her work. She is in operating-room garb, and her hands and arms have been thoroughly disinfected. She has consulted her instrument-list and has seen that everything is prepared and in good condition. The knives all have keen edges, and these and other things made of metal or rubber are boiling in a one-per-cent. soda solution. An abundance of sterilized gauze, sponges, dressings, and towels are ready. The temperature of the room has been properly regulated.

The operating-table is prepared in the following way. A folded blanket or, better still, a felt pad, large enough to cover it, is placed upon the table. Over this is spread a rubber sheet, which in turn is covered with a fresh white sheet. The head of the patient is to rest upon a small hair-pillow or upon an air-pillow, and the rubber ovariotomy pad (Fig. 31) is placed in position. With the Boldt or some similar table this is not needed, as all fluids drain into a bucket placed beneath the table.

Some surgeons prefer to employ the Horn-Martin or the Trendelenburg position for their operations. The

FIG. 31.



Rubber ovariotomy pad. (Kelly.)

operating-table used by Martin is somewhat shorter than usual, and as the patient lies upon it the buttocks are placed near the edge and the legs are allowed to hang down. The surgeon sits on a chair between the patient's thighs, and is thus able to hold them steady without being obliged to support them. Besides the fact that the position is somewhat awkward, there is the objection that a larger incision is required in order to expose the pelvic structures than would otherwise be necessary. The advantages claimed for the table are (1) the facility given for making the first incision by the tension of the abdominal wall, (2) the inclination given to the pelvis of the patient, by which the examination and manipulation of the organs are rendered easier, and (3) the saving of fatigue to the surgeon, who is able to sit down during the entire operation.

To Frau Horn, Dr. Martin's head operating-room

nurse, belongs the credit of suggesting a further improvement in the construction of the table. A section of the middle portion of the top is so arranged that it can be let down, thus permitting the abdominal dressing to be applied with greater facility.

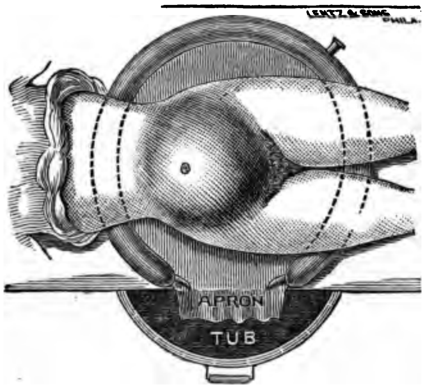
The Trendelenburg position, in which the pelvis is elevated, has been considered to be of especial value in exposing the pelvic contents to view. While the patient is in this position the intestines are not so likely to obstruct the necessary manipulations, since by the action of gravity they are naturally displaced upwards towards the thorax. What would appear at first sight to be a somewhat serious objection to its adoption—namely, that it favors the spreading about among the intestines of any fluids that may be present in the pelvis, thus increasing the danger of the carriage of septic material into the abdominal cavity—has been fully disproved by a mass of clinical and experimental evidence.

The various basins which will be required are conveniently arranged on the side tables. The sterilized salt solution and a plentiful supply of distilled water in large granite-ware vessels are being heated over Bunsen burners. When these matters have been attended to, the nurse gives her hands a second disinfection, after which she must not touch anything which might contaminate them, and must leave it to the assistant nurse or attendant to do anything which necessitates the handling of unsterilized articles.

The surgeon and his assistants have arrived in good

time; in their dressing-room they have removed their ordinary clothes, and have put on their operating-suits; they have then entered the operating-room long enough before the operation to give themselves ample time to complete the disinfection of their hands and forearms. None of them should have been in contact with septic material for the forty-eight hours preceding. Any visitors who are admitted are to put on over their ordinary clothing the long, loosely-fitting, freshly-washed linen dusters with which they have been supplied. The partly-anæsthetized patient is now put upon the table, the hips being placed over the rubber pad which is to conduct the waste fluids

Fig. 32.



Rubber ovariotomy-pad in position.

over the side of the table into a large vessel. (Fig. 32.) The night-gown and undervest are rolled up

over the elbows to hold the arms still. The final disinfection of the abdomen now takes place. The assistant nurse hands to one of the surgeons a basin of warm water, scrubbing-brush, and green soap, and the parts are once more thoroughly cleansed. The soapsuds are rinsed off with sterile water, and the surface of the abdomen is next sponged (sterilized gauze sponges being used) with ether or strong alcohol. After a further washing with a one to one-thousand sublimate solution, the excess of sublimate is washed off with sterilized water or salt solution. Having now rendered the skin of the patient as nearly aseptic as possible, we try to keep it uncontaminated by covering the patient from shoulder to feet with sterilized towels arranged over the abdomen so that the field of operation can be exposed while at the same time the flanks are protected. Over the towels a large sterilized sheet is placed in position with an opening in the median line sufficiently large to permit of the necessary manipulations. Finally, the adjacent parts of the patient's body and of the operating-table are completely covered with sterilized towels, and the operation will be done through the artificial opening in the gauze over the abdomen. The assistant at the head of the table completes the anæsthesia, and the patient is ready for the first incision.

The special duties of the different assistants and some other points are deserving of mention. The operating-table is placed so that a good light shall, when the surgeon is in position, fall upon the field of oper-

ation. The surgeon stands, of course, upon the right of the patient, and his first assistant stands opposite him upon the left side. The latter holds hæmostatic forceps in his hand all ready to check the hemorrhage, and also attends to the sponging.

In order to do the most satisfactory work, the surgeon will require a liberal number of helpers. He should have, as a rule, three, four, or even five assistant surgeons, besides two nurses. Directly opposite him should stand the first assistant, and on either side of the table there should be an assistant. One of these should have the entire charge of the instruments and ligatures, while the other should look after the sponges and dressings which may be required during the operation. The first assistant should help the operator directly, and, unless his hands are occupied in holding apart the structures or in other manipulations, the sponges and instruments should generally be passed to him.

The assistant to whom the administration of the anæsthetic has been intrusted should give his undivided attention to this duty.

A fifth assistant is of especial value if cultures have to be made or if any microscopical work is necessary during the operation. The head nurse in the operating-room watches for any opportunity to be of service to the surgeon and his assistants. She must, as we have said, touch nothing which is not sterile, and indeed there is no necessity for her to contaminate her hands, as to the second nurse are relegated all duties

which involve the handling of any articles which have not been rendered aseptic.

About the operation itself it is necessary to make here only a few general remarks. The special points are considered at length in other works in which the methods of the different abdominal operations are discussed. The incision should be made in the median line with a sharp scalpel, starting midway between the umbilicus and the symphysis pubis, and being carried towards the latter. It should not, however, extend quite to the symphysis pubis, and care must be taken that the bladder shall not be injured. The first stroke of the knife cuts down to the superficial fascia. After the hemorrhage has been checked, this is divided exactly to the linea alba. Next come two fibrous layers between which is a variable amount of fat, after which there is a thin layer of fat directly above the peritoneum. The assistant should keep the parts clean by pressing a sponge firmly along the line of incision and then removing it quickly. The sponge is never to be rubbed along the line of the wound. After the tissues have been separated down to the peritoneum, this is lifted up with a pair of dissecting forceps. The assistant opposite the operator now with a second pair of forceps takes hold of another portion of the peritoneum at a short distance from the first forceps, and while he raises it, the operator divides the peritoneum very carefully at a point between the two forceps. This precaution is necessary in order to avoid any possibility of injuring the intestines. At the moment

the peritoneal cavity is opened air will enter, and the intestines, unless they are adherent, will fall away from the parietal peritoneum, making its further section free from danger. After the peritoneum has been divided for the full length of the incision through the skin, the abdominal structures are palpated with the left hand, and after a careful examination it will be possible to decide whether or not it will be advisable to enlarge the incision. If this is thought necessary, there should be no hesitation in doing so, as a better exposure will thus be obtained and all the manipulations will be much expedited.

If cysts have to be punctured and evacuated, great care should be taken that none of the contents gain entrance into the peritoneal cavity, particularly if the cyst be papillomatous, since the fragments which escape may become implanted upon the peritoneum and give rise to malignant metatastic growths. Before the sac is punctured it is well to place a large sponge or piece of gauze round it, in order to absorb any fluid which we might otherwise not be able to catch. Should any fluid or particles of papillomatous growths in spite of our efforts have been carried into the abdominal cavity, they should be carefully sponged out. A collection of pus before being opened into must always be walled off from the peritoneal cavity.

After the diseased parts have been excised and the pedicle firmly ligatured, the surgeon makes the peritoneal *toilette.* If there has been no escape of fluid and no free oozing into the abdominal cavity, it is not

necessary to employ any irrigation, and it will be sufficient if the peritoneal cavity be sponged dry, particularly the portion posterior to the uterus. To do this the uterus is held well forward with the left hand, so that the sponges can be carried well down into the cul-de-sac. (Fig. 33.) All ligatures should now be

FIG. 33.

Sponging out cul-de-sac.

well inspected before the ends are cut off, and, if there is little or no oozing and the pedicle does not retract from the ligature, the latter may be cut off about one centimetre from the knot.

When adherent structures are to be removed the technique to be carried out is more difficult than when they are free. It is in these cases that the larger abdominal incisions are required. Fortunately, adhesions are more rare now than of old, since patients submit to

an operation earlier and the previous puncture of the abdomen for diagnostic purposes or for drawing off fluid is less common. If the intestines obstruct the field of operation, they can be kept out of the way by pushing them back and covering them with a large sponge or with a large piece of sterilized gauze wrung out of hot water or hot salt solution. The adherent structures are to be separated by gently working the adhesions loose with the fingers, every precaution being exercised in doing this to avoid any laceration of the abdominal organs, particularly of the intestines and bladder. If we find it impossible to separate the structures at any one place in this way, we proceed to make attempts to do this at various points until we find a point where the adhesions are less firm. This will frequently require considerable time, but it pays to "make haste slowly," since in the great majority of cases grave injuries can be thus avoided. If there should be much hemorrhage following such removal, it can frequently be checked by washing the peritoneal cavity with hot sterilized salt solution, or often, if the adhesions are fresh, simple pressure made with a sterilized sponge will arrest the bleeding. Where the adhesions are old and firm and the hemorrhage is persistent, the bleeding points must be ligated. In desperate cases of bleeding from the uterus, where all the ordinary means have failed, the hemorrhage can generally be checked at once by tying the ovarian or uterine arteries, or by packing the pelvic cavity with

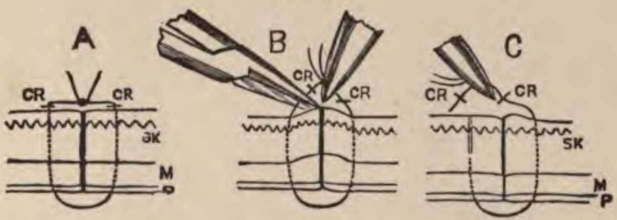
ten-per-cent. iodoform gauze which has been wrung out after being dipped in very hot salt solution. When much oozing occurs over a large area, it may be controlled by sterile iron subsulphate or by the tip of the cautery (at a dull-red heat), applied lightly over the bleeding surfaces.

The abdominal cavity is closed by first uniting the peritoneum by means of a continuous suture. (The question of drainage has already been discussed in Chapter VIII.) The skin and muscular surfaces are then brought together with deep sutures of silkworm-gut and silk. As a rule, we unite the fascia with buried silver-wire mattress sutures and the skin with a subcuticular catgut suture. If Halsted's subcutaneous suture is employed, the stitching of the muscular and skin surfaces can be done separately. After the wound has been properly closed, we have to decide upon the most suitable method of dressing it. The following procedure has yielded very satisfactory results. After the sutures have been tied, the incision and the immediate field of operation are cleansed with sterilized salt solution, followed by alcohol, after which they are gently dried with a sterilized towel. Over the site of the incision dry sterilized iodoform powder is sprinkled, over which come two thicknesses of sterilized gauze and a sufficient quantity of sterilized cotton, so that not only the wound but the whole abdomen is thoroughly protected from the symphysis pubis to just above the umbilicus and from flank to flank. This

dressing is held securely in place by means of strips of adhesive rubber plaster reaching from the unsterilized flank on one side to that of the opposite side. The whole is then covered with a sterilized scultetus bandage. This dressing in our hands has proved most satisfactory. We have found that even in the case of restless patients, who have moved about in bed a good deal, the wound has never been exposed on account of the slipping out of place of the dressing, and infections of the skin have been very rare. For the occlusive dressing, formerly much employed, a strip of sterilized gauze is placed over the incision and saturated with bichloride celloidin (p. 137), being covered in turn by a similar but wider strip, the second piece of gauze protecting a wide area of skin around the wound, while the first strip covers the incision itself. In ordinary cases the wound need not be disturbed for a week or more. When the dressing is to be removed, it will generally be necessary to moisten it thoroughly by applying to it for an hour a pad of absorbent cotton which has been soaked in sterile water or in a one to forty carbolic acid solution. If, however, we wish to remove it quickly and without causing pain, ether may be poured directly upon the dressing, which, as a rule, can then be readily removed. If the dressing still adheres to the stitches, we can cut them free from the gauze and remove them later. In removing the cutaneous sutures the loop is to be cut below the point where the celloidin and powders are encrusted, and at a point where the suture is moist and pliable. In this

way we avoid dragging the ragged and rough part of it through its whole track. (Fig. 34.) The subcutaneous suture probably has the advantage of lessening the chances of stitch-hole infection. After the stitches have been removed, the dry dressing of iodoform and boric acid powder (one to seven) or subiodide of bismuth powder is applied to the wound. Over this it is better to place a piece of plain sterilized gauze, and if

FIG. 34.



Removal of the abdominal suture. *A* shows the suture *in situ* passing through skin, muscle, and peritoneum. *CR, CR* are the little masses of incrustation of hardened lymph discharged from the suture-track. *B* shows the removal of the suture, elevated and cut below the crust. *C* shows the direction in which it is to be pulled out. (Kelly).

there is any tendency to separation of the edges of the wound it will be well to apply an additional strip about six centimetres (two and a half inches) in width over the surface, the whole dressing being kept in place with cotton and the many-tailed bandage. Dr. Halsted prefers to dress the wound of an abdominal section with strips of sterile gutta-percha tissue or leaflets of silver-foil, which are applied immediately along the line of incision, thus protecting the granulations which form; he believes that the removal of ordinary dress-

ings into which the granulations have grown is very injurious to the wound. In his dressings no powders or celloidin are applied, but pieces of dry sterilized gauze and cotton are placed over the protective, the whole being held in place by an abdominal bandage.

Fig. 35.

Fig. 36.

Robb's leg-holder.

Where the operation is to be upon the perineum, upon the vagina, or upon the uterus through the vagina, the external genitalia and adjoining parts will require more careful preparation. All the hair should be shaved off, and the parts should be thoroughly

PLATE XXII.

Field of operation and the neighboring parts protected by gauze diaphragm, towels, and stockings.

scrubbed twice daily with soap and hot water for two or three days, and on the morning of the operation they should be thoroughly cleansed with alcohol and ether and afterwards with sublimate solution. The bladder and rectum are, of course, to be thoroughly emptied before this cleansing. The patient is anæsthetized, brought to the operating-table, and placed in the dorsal position. The legs are flexed on the abdomen, and may be conveniently held in place with the simple leg-holder shown in the figure. (Figs. 35 and 36.) The external genitalia and the vagina are again scrubbed with soap and warm water, and the skin about the parts and over the thighs is irrigated thoroughly with a one to one-thousand solution of sublimate and afterwards with sterile water. The parts are then protected with a large piece of gauze, in which a hole is cut large enough to expose thoroughly the perineum and vaginal outlet, and allow all the necessary manipulations. (Plate XXII.) If a continuous stream of sterile water or salt solution be kept playing over the field of operation, sponging will be unnecessary and the operation will progress more speedily.

CHAPTER XIII.

POST-OPERATIVE CARE—POSITION IN BED—DIET—VOMITING—RECTAL FEEDING—SHOCK—PAIN AND RESTLESSNESS—CONSTIPATION—CATHETERIZATION—CONVALESCENCE—REMOVAL OF STITCHES—DRESSINGS SUBSEQUENT TO OPERATIONS—HEMORRHAGE—INTESTINAL OBSTRUCTION—INFECTION.

IMMEDIATELY after the operation has been finished and the dressings have been applied, the patient, not yet completely recovered from the anæsthetic, is removed to the bed where she is to remain until convalescence. The after-care of operative cases is naturally of very great importance, and mistakes in treatment are often attended by the most serious results. The nurse in charge should be one who has had special experience in abdominal work, and none should be chosen who is not specially fitted for the post. At first the patient is to be kept quietly in bed in the recumbent position, and she must be closely watched until she has fully regained consciousness. Of the dangers from vomiting during the semi-unconscious stage it is scarcely necessary to speak. When it occurs, the head should be turned on one side and the nurse should have a basin ready to place beneath the patient's chin for the reception of vomited or mucous material, so that any soiling of the night-dress and of the bedclothes may be avoided. Every precaution must be taken to keep up the strength of

the patient and to keep her warm and comfortable. Exposure to draughts or allowing her to become chilled in this condition of lowered resistance may easily prove to be the exciting cause of a serious bronchitis or pneumonia. Hot cans (Fig. 37) are to be

Fig. 37.

Hot-water can.

placed round her in the bed, care being taken that the skin shall not be burned. This may easily be avoided by placing a blanket between the can and the surface of the body. Neglect of this simple measure has before now led to serious superficial burns, which have delayed convalescence and have proved a source of much annoyance to both physician and patient.

It is extremely difficult to lay down definite rules regarding the food and drink to be ordered after abdominal operations. Where a plastic operation has been performed upon the perineum and cervix, the problem is comparatively simple, and after the early nausea has disappeared a light soft diet may very soon be allowed; but where the patient has undergone an abdominal section the greatest care has to be exercised. With

ordinary simple cases a light soft diet may be given after the first twenty-four hours, but where the operation has been a serious one, or where the viscera have been much disturbed, the woman must be kept as quiet as possible, and frequent feeding by way of the stomach cannot be permitted for some days. In all such cases a great deal of tact and patience will be required. Milk is not a good substance to give by the mouth after abdominal sections in the majority of cases. In the first place, it is not easily digested in the stomach, and the curd remaining may pass along the intestines and act as an irritant. In the second place, milk very often causes flatulence and produces much discomfort. Peptonized milk would be free from this objection; but patients, as a rule, complain of its bitter taste, and it is difficult to get them to take it more than once or twice. During the first six or twelve hours it will be found preferable, if there be any vomiting, to give the patient by mouth nothing except small quantities of toast-water or of warm water, from one to two teaspoonfuls every fifteen or twenty minutes. This frequency of administration is generally not only tolerated, but is very comforting to the patient, from the fact that it tends to relieve the thirst which is complained of, and sometimes will diminish the vomiting as well. It will occasionally be desirable to give nutritive enemata at intervals of three or four hours. They should not be given more frequently than this, for fear of rendering the rectum intolerant of them. The enema should consist of milk with whiskey or brandy, together with

the white of an egg and a little common table salt. The following proportions make a good combination, and the enema may be given by means of a hard-rubber syringe or through a rectal tube.

> ℞ Peptonized milk, 30 cc. (℥i);
> Whiskey, 30 cc. (℥i);
> The whites of two eggs;
> Common table salt, 1.5 (grs. xxiv).

The rectum should be thoroughly irrigated once or twice daily with warm physiological salt solution, which will keep it clean, so that the nutritive enemata will be better absorbed.

Often, besides the warm water and toast-water, fifteen or twenty drops of sherry with one or two teaspoonfuls of soda-water, given at frequent intervals, will be retained by the stomach. This method of treatment can be kept up for the first day or so. After this, if the patient is still willing to take a fluid diet and there is no vomiting, the quantity of the liquids may be gradually increased. At the end of the third day we may begin with small quantities of milk and lime-water by the mouth, if the patient cannot take the peptonized milk. It is better to give this in the proportion of two parts of milk to one part of lime-water, slowly increasing the quantity of the former each day and diminishing the amount of the latter until the patient is taking three parts of milk to one part of lime-water. It is unwise to give cold water to drink to quench the thirst, and the custom of allowing the patient to suck

ice is not a good one, as neither is nearly so efficacious as warm water, and the patient is never satisfied, but is always asking for more. Besides this, the ingestion into the stomach of much cold water or ice soon causes nausea, and may thoroughly upset the stomach and thus add considerably to the discomfort of the patient. If she still complains of distressing thirst, an enema consisting of five hundred cubic centimetres (one pint) of tepid water may be slowly administered. This may be repeated if necessary, and is generally most satisfactory in its results. If the patient does not vomit at all or only at infrequent intervals, after some six or twelve hours, home-made beef-tea or beef-jelly, in teaspoonful doses, either concentrated or diluted, may be given.

The above treatment applies to those cases which proceed easily and rapidly towards recovery. When, however, the vomiting is persistent and aggravated, it becomes a most troublesome symptom, and one which taxes severely the ingenuity of the surgeon and of the nurse. The vomiting which follows anæsthesia may sometimes be relieved by allowing the patient to rinse out the mouth with warm water, a procedure which will often help to relieve the thirst, which is at times almost unbearable. While the nausea and vomiting continue, the head should rest on a level with the body or be only slightly elevated on a small pillow. As a rule, the vomiting due to the anæsthetic is over by the end of eighteen or twenty-four hours, and when this symptom continues after the third day, and par-

ticularly where the fluid is expelled without much apparent effort, in too many cases peritonitis is to be feared. After the second or third day, if there still be a great deal of nausea, it may sometimes be relieved by giving two or three tablespoonfuls of very hot water containing from twenty-four to thirty centigrammes (four or five grains) of bicarbonate of sodium to thirty cubic centimetres (one ounce) of water. This may be repeated every hour or so, and where it does not succeed, a mustard leaf may be applied over the epigastrium. In a certain number of cases the washing out of the stomach may be of service.

The vomiting which accompanies a marked septic condition, such as a general or a localized peritonitis, is, however, most resistant to treatment. In the majority of cases this symptom is aggravated instead of being relieved by the administration of drugs especially directed against it, and the treatment of the accompanying constipation or tympany is more likely to stop the vomiting. Occasionally (but only as a last resort) it may be necessary to give a hypodermic injection of morphine over the epigastrium for the relief of the severe retching, if there is reason to fear that it will otherwise soon exhaust the patient.

In those cases where the operation has been a long one, or where the viscera have been much disturbed, it becomes necessary to employ unusual methods of stimulation to tide the patient over the stage of shock until she reacts. Into the question of the true nature of "shock" and the phenomena of "reaction" we shall

not go now. What little is known about them can be obtained from the text-books on general surgery. The treatment may be briefly outlined as follows. The patient should be kept warm; she should be enveloped in blankets, and hot-water cans or hot sand-bags should be applied round the trunk and thighs and to the soles of the feet. Stimulating applications may be cautiously made over the epigastric region, and if necessary the legs and forearms may be enveloped in cloths wrung out of hot water; while in alarming cases hypodermic injections of ether, brandy, whiskey, or camphor are given every few minutes or every half-hour, according to the urgency of the symptoms.

Nearly every patient is restless and suffers more or less pain during the first twenty-four hours after an operation. Not every complaint must be met with drugs, and a skilful nurse can do much to relieve many of the little discomforts of which the patient complains. A slight change in position, made by putting a soft pad or pillow under the head and shoulders or under the bend of the knees, so that the legs are supported in a flexed position, will often do much to effect this. The arms, legs, and chest may be sponged with warm alcohol or with soap and warm water. After the first day, if the patient is still restless and there is no contra-indication, it will do no harm to transfer her once in the twenty-four hours from one bed to another which has been already prepared and dressed with warm clean linen. This, if done in the evening, very often succeeds in giving the patient a good night's

sleep. Convalescence is promoted also by frequent spongings and by rubbing the body with alcohol. If, in spite of our efforts, the patient continues to be very restless, especially at night, the administration of an enema consisting of three or four grammes (48 to 64 grains) of bromide of potassium with from fifteen to thirty cubic centimetres (℥ss to ℥i) of milk of asafœtida may be tried, and if necessary repeated in an hour or two. If the restlessness still persists, or if the patient suffers severe pain, it may be necessary to give morphine in doses of from ten to sixteen milligrammes ($\frac{1}{6}$ to $\frac{1}{4}$ grain), which may be repeated according to the effect produced. Morphine, however, should never be used unless all other measures fail. It is much better to encourage the patients to control themselves and to bear the pain, telling them that it will not last long, and that they will be in every way much better if they can endure it for a short time longer without taking medicine for its relief. The routine employment of morphine is to be condemned. The healing always proceeds better without it, and there is little doubt that the surgeon is often directly responsible for the formation of the morphine habit. Unfortunately, the practice of giving this drug as a matter of course after operations is apparently becoming more and more wide-spread. It is popular, perhaps, because it affords immediate comfort to the patient and to the surgeon. It is not an infrequent practice of surgeons to keep their patients under the influence of morphine for the two or three days subse-

quent to the operation. Its use is occasionally a necessity, but in the vast majority of cases I feel sure that a patient does not require any sedative at all after an operation, especially if we enlist on our side her own moral support. The danger of using morphine after operations lies in the fact that after a short time the patient not only feels the necessity of its repeated use, but is also much more difficult to manage; she becomes restless and fretful, complaining loudly of the most trivial suffering, and her *morale* suffers so much that at times her mind becomes unbalanced. In the after-care of over one thousand cœliotomies, only in rare instances have we found it necessary to give a dose of morphine, and even then in some of the cases in which it was given there was more than once occasion to regret its employment.

In the majority of cases it is well that the bowels should be opened on the second or third day after an abdominal operation. The giving of medicines by the mouth for this purpose is often contra-indicated, especially in the cases in which there is much nausea. The most satisfactory method consists in the administration on the second day of an enema consisting of five hundred cubic centimetres (one pint) of soapsuds and warm water, given as high up as possible. To do this, the rectal tube having been introduced well up into the rectum, to the external end a small glass funnel is attached; the mixture of soap and water is poured into it and allowed to run slowly into the bowel. Sometimes a litre can be introduced in this

way. If the enema has not been effectual, it may be repeated after three or four hours, or an enema may be given consisting of warm water, oil, and turpentine in the following proportions:

> Plain warm water, 500 c.c. (Oj);
> Olive oil, 60 c.c. (℥ii);
> Turpentine, from two teaspoonfuls to a tablespoonful.

This may be repeated once or twice at intervals of two or three hours, but generally the first enema is followed by a satisfactory evacuation of the bowels. If preferred, the first enema may consist of from one hundred and twenty to one hundred and eighty cubic centimetres (℥iv to ℥vi) of warm olive oil or glycerin, to soften any fecal matter that is in the rectum, and an hour or so later it may be followed by a second made of soapsuds and warm water. Sometimes an enema consisting of a pint of warm soapsuds and water mixed with thirty grammes (℥i) of Epsom salts will act where others have failed. If, however, there are no contra-indications to the giving of medicine by the mouth, in addition to using the enema we may give by mouth about one-third of a bottle of the effervescent citrate of magnesium, to be repeated every two hours until the bowels have been opened. Some, again, prefer a Seidlitz powder to be taken on the second morning after the operation, and in other cases it may be advisable to give calomel in doses of from ten to thirty milligrammes ($\frac{1}{6}$ to $\frac{1}{2}$ grain) every two or three hours at night, to be followed by a Seidlitz powder

on the next morning. The compound liquorice powder is a favorite laxative with some surgeons.

If the employment of these measures fails to produce an evacuation of the intestinal contents, the existence of an obstruction of the bowels is to be suspected, and the question of resorting to operative measures has to be considered.

After the bowels have been thoroughly opened the patient may complain of a feeling of weakness, and sometimes, indeed, there is a considerable degree of prostration. In order to counteract this condition it may be necessary to give a warm enema containing a stimulant, one consisting entirely of peptonized milk with the addition of brandy or whiskey being often very useful. After plastic operations upon the perineum it is, of course, absolutely necessary that there should be no straining at stool, and after each movement the parts must be carefully cleansed, on account of the danger of infection.

Catheterization of the patient at stated intervals after an operation is advised in most of the text-books. This procedure is, however, by no means always necessary. As a rule, the urine need not be drawn off for at least six or eight hours, if this is done immediately after the operation before the patient leaves the table. It is a good plan to wait until the patient has expressed a desire to micturate, and has been allowed to attempt to void her water voluntarily without success before employing the catheter. If she is encouraged to try to pass her urine, in some instances cathe-

terization will not be necessary at all. During the first twenty-four hours the secretion of urine is scanty, and it would therefore seem unnecessary to draw it off more frequently than every six or eight hours. The troublesome cystitis which sometimes follows catheterization may generally be avoided by the exercise of the proper precautions, as we have already shown in an earlier chapter. (Chapter X.) In plastic cases it is particularly important, of course, that catheterization be done aseptically and that the field of operation be not irritated by urine.

In every case for a certain time after an abdominal section the patient should remain in the recumbent position as much as possible. The maintenance of such a position, of course, is particularly desirable if the drainage-tube has been employed, lest the structures be injured or the tube displaced. After the first ten or twelve hours immediately following an ordinary abdominal section, if there is no contra-indication, the patient may with safety be placed on her side for a few minutes at a time, while the back is supported by pillows. This, indeed, may often be permitted even earlier, if the drainage-tube has not been used and if the patient has vomited but little. The change of position from the back to the side, if it adds to the comfort of the patient, may be made every two or three hours during the day and night. While the patient is lying on her side the back and legs may be well rubbed with alcohol, after which the bed will not feel so uncomfortable when the dorsal position is re-

sumed. As a rule, the patient should not be allowed to sit up in bed until the sixteenth or eighteenth day after an abdominal operation, and even then the first attempts should be limited in duration to a few minutes, and should not be made without the use of the bed-rest to support the back and head. Gradually the time may be prolonged, until at the end of the third week the patient may be allowed to get out of bed; but on the first day she should simply be wrapped in a blanket and placed in a rolling- or rocking-chair for ten or fifteen minutes, and at the expiration of this time should be put to bed again. On the next day, if the first getting up has not tired her too much, she may be allowed to sit up a little longer; and on the third day the time may be extended to an hour or perhaps more, and increased every day until she can sit up all the morning and finally during the entire day. About the end of the fourth week she may be allowed to walk, but only for a few steps at a time. She should, however, avoid going up- and down-stairs and lifting anything for some days. The observance of these precautions is important, for if they are neglected many patients will subsequently complain a great deal of the backache and general weakness which often follow a too early getting about. Before the patient is permitted to get out of bed she should be furnished with an abdominal bandage (Fig. 38), which not only will tend to prevent any opening of the incision, which might be followed by a hernia, but will also add a great deal to the patient's comfort by

supporting the abdominal walls. This bandage should be used for from six months to a year. After it has

Fig. 38.

Abdominal bandage.

been worn for about three weeks it need not be kept on during the night while the patient is lying quietly in bed.

After a trachelorrhaphy or a perineorrhaphy has been performed the patient is generally allowed to sit up in bed with the bed-rest or supported by pillows on the tenth or twelfth day, and on about the seventeenth day after the operation she may get out of bed. Any internal stitches may be removed at the end of the third week, and the patient can then begin to walk around slowly, provided that she is very careful not to do too much and is particularly cautious in going up and down the stairs. After an operation upon the perineum the patient should keep in the recumbent position for the

first ten hours. After this, if she is restless and complains of pain in the back, or if she desires to change her position, she may be carefully turned on her side. A small soft pillow should be placed between the knees. A bandage around them will seldom be necessary, as the patient can generally be induced to keep the knees sufficiently close together, and if she is told to keep the internal surface of one as nearly as possible opposite to that of the other, there will usually be no harm done by dispensing with the bandage. The T bandage which is applied over the line of the wound will sufficiently protect it from any injury of the parts which might otherwise be caused by movements that the patient makes in turning over. As a rule, after the first two or three days the patient may assume the position which she finds most comfortable.

In ordinary section cases where the abdomen has been closed without drainage, the stitches may be removed on the seventh or eighth day. Some of the precautions to be observed when removing the stitches have already been referred to in Chapter XII. Naturally, the hands are to be disinfected whenever a wound is being cared for. After the removal of the stitches the incision should be protected by some sterile non-irritating material, such as gauze impregnated with iodoform, or sterilized cotton, or else a powder consisting of iodoform and boric acid (one to seven) may be dusted freely over the parts. Over this, again, some sterile cotton may be applied and held in place by a many-tailed bandage. This dressing need not be

changed more frequently than once every two or three days, or until the wound becomes dry, after which it is only necessary to place a strip of sterile cotton over the line of incision, which can usually be dispensed with after the third week subsequent to the operation.

After a trachelorrhaphy or a perineorrhaphy has been performed about two drachms of sterilized iodoform are dusted into the vagina. A strip of sterilized gauze is inserted, but is removed within twenty-four hours after the operation, and, as a rule, need not be reapplied. Over the external wound iodoform and boric acid powder (one to seven) or subiodide of bismuth powder may be applied, and gauze and cotton held in place by a T bandage, which must be changed as often as it becomes soiled. The bandage and external dressing will generally not be required to protect the parts after the external stitches have been removed.

Tympanites, a by no means uncommon symptom following abdominal operations, is most frequently caused by constipation, and in that case is usually relieved when the bowels are evacuated. It may give rise to severe pain, and, by causing pressure upon the diaphragm, often embarrasses the action of the heart and lungs and leads to acceleration of the pulse and respiration. One or two drops of the tincture of capsicum in a teaspoonful of warm water every half-hour for three or four doses, or fifteen to twenty drops of the essence of peppermint, will prove an effectual remedy for the more simple cases. At the same time

a mustard leaf or a warm application, such as a turpentine stupe, may be applied over the epigastrium, care being taken not to leave it on long enough to cause a blister. If the tympanites still continues after the bowels have been well opened, it will be well to pass a rectal tube, which has been previously well warmed and oiled, into the bowel for a distance of fourteen inches, and thus get rid of the accumulated gases.

Hemorrhage, and especially *intra-peritoneal hemorrhage*, will rarely be met with after operations, if the technique of the surgeon has been good. When, however, it does occur, and the loss of blood is considerable, the condition may soon become serious. The symptoms which follow such an accident must always be carefully watched for after any abdominal operation. The lips grow pale, the face takes on a fixed expression, the pupils are dilated, the surface of the body soon becomes covered with a clammy sweat, the extremities are cyanosed, and the patient complains of dizziness, or even loses consciousness. When the hemorrhage is extensive, the only hope lies in reopening the wound and ligating the bleeding vessels. Hemorrhage following stitch-hole wounds seldom assumes any serious proportions.

Peritonitis, by which we mean an infection of the peritoneum either local or general, is always an unfortunate complication. Not every case of tympanites with distention is due to peritonitis. It is only when one gets the array of symptoms which form so striking a clinical picture—the pain, the distention, the drawn

expression of the face, the pinched look about the nostrils, and the wiry pulse—that one is justified in positively diagnosing an acute peritonitis. Of stitch-hole infection we need not speak here, except to point out that the elevation of temperature which accompanies it does not usually appear before the second week.

CHAPTER XIV.

OPERATIONS IN THE COUNTRY, IN PRIVATE HOUSES, OR IN OTHER PLACES WHERE THE TECHNIQUE MUST NECESSARILY BE MORE OR LESS IMPERFECT—THE ARMAMENTARIUM—AN IMPROVISED OPERATING-ROOM—MODIFICATIONS IN TECHNIQUE.

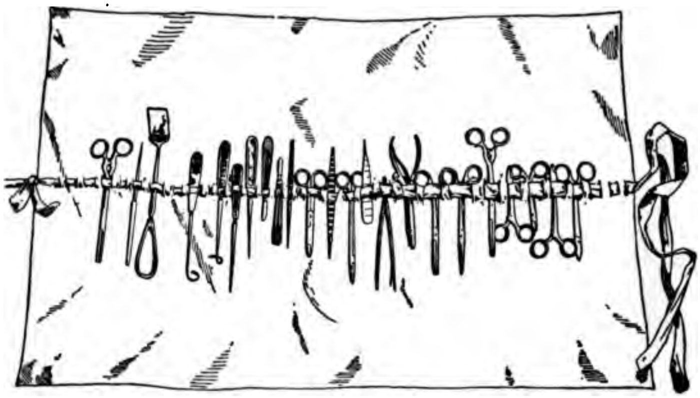
EVERY time that a surgeon is called upon to operate at a distance from the hospital or from his regular operating-room, he has to encounter many difficulties in the way of maintaining asepsis. It is, however, just under these circumstances that the well-trained operator who has mastered the principles underlying surgical technique will be able to utilize this knowledge while adapting himself to his surroundings. Even if he is called upon to operate on the shortest notice he need never be taken by surprise, and even if the conditions are the most primitive, so long as he has fire, water, and vessels, he is in a position to carry out an aseptic technique. Boiling water will give him sterile instruments, ligatures, and dressings,—though there are other and better ways of obtaining these,—and it will be possible for him to regulate his surroundings with a fair degree of satisfaction to himself.

A surgeon who is frequently called upon to do operations away from home will find it convenient to have a set of instruments, dressings, and other necessaries

already packed in a transportation valise, or to have these kept apart and always sterile, so that they can be put together in a few moments. The instruments and all the dressings should be rendered sterile in the same manner as when preparing them for operations in the hospital. The materials that are required can be supplied from the regular stock in the operating-room. If one has not the advantage of an operating-room supply to draw upon, then it will be well to furnish a room adjoining the office, so that the materials can be kept in good order after they have once been sterilized. Before going to an operation the instrument-list should be consulted, and one must be particularly careful to make sure that nothing that will be required is left out, since away from home it will not be possible to make a requisition upon the stock instrument-case for any article which has been forgotten. The surgeon should give the preparation of the outfit his personal attention, or intrust it to a trained assistant or nurse whom experience has proved to be competent. For many reasons it is better to sterilize the instruments and dressings at the place where the operation is to be performed, in which case it will be necessary to take along the small soda solution apparatus (Chapter V.) and an Arnold steam sterilizer. If for some reason or other this is impossible, they may be sterilized before the surgeon sets out, and afterwards conveyed to the place of operation under aseptic precautions. If the instruments are to be sterilized after arriving at the house, they can conveniently be carried arranged in

compartments in a long sheet of canton flannel, which is then rolled up and tied round the middle with a

FIG. 39.



Canton-flannel sheet for instruments.

broad tape. (Figs. 39 and 40.) If they have been sterilized at home, they may be carried in stout sterilized bags made of butcher's linen, and closed by a draw-string. It will be found convenient to have several sizes of these bags, so that the more bulky instruments may be kept in the larger and the knives and forceps in the smaller ones. Three or four hard-rubber trays for the instruments should be included in the outfit, and should be made so that they may fit into one another ("nests"), and thus not occupy too much room. A box made of nickel and shaped like a telescope valise is a good instrument-holder. Sterilized nail-brushes may be rolled up in a sterile towel or carried in a well-stoppered jar containing carbolic acid solution. Good

soap in tin cases, and air-tight screw-capped bottles containing potassium permanganate and oxalic acid, and a good supply of green or oleine soap must not be forgotten. The sterilized gauzes, cotton, sponges, and bandages are best rolled up in sterilized towels and enclosed in sterilized gauze or bags. It will be better to have at the operation a few wide-mouthed sterilized glass jars which hold from one-half to two litres and

FIG. 40.

Instruments wrapped in canton-flannel sheet.

are fitted with air-tight covers. The ligatures are carried in the large ignition tubes, which are plugged with cotton stoppers and have been sterilized in the manner before described. Several tubes may be carefully rolled up in a towel. The outfit should include a liberal supply of towels, rubber gloves, and mackintoshes.

It is well to collect everything before commencing to pack the valise, so that each item on the list may be

checked off as the article is put in. The "telescope" valise will be found most serviceable and convenient. It has also the advantages of being inexpensive and of being easily cleaned, and things packed in it can be transported safely. The surgeon who has many outside calls will find it very convenient to have two or three bags always ready, one containing the necessary instruments for abdominal sections, a second those required for the ordinary plastic cases, and a third those employed in the simpler operations, such as dilatation and curettement.

In handling the articles and preparing the outfit it is essential, if they are sterilized, that the person who does this shall prepare his hands and forearms as carefully as if for an operation.

The inside of the valise, particularly the lower half, should be well protected with sterilized towels or with a piece of muslin sufficiently large to be folded entirely over the contents after they have been put in. In packing the glass-ware great care should be taken to avoid breakage upon the journey.

In order still further to preclude the possibility of any contamination during transportation, we can wrap the bags containing the instruments, cotton, towels, and trays in a piece of sterilized rubber mackintosh. After the valise has been well packed and the top has been properly adjusted, it should be fastened snugly with the leather straps.

The operating-room should be chosen with special regard to two requirements,—viz., (1) that it is well

lighted, and (2) that it can be easily cleaned. To select it, if possible, an assistant or nurse should be sent to the house a few days before the operation. The nurse, besides, should be with the patient for two or three days, in order that all the necessary preparations may be made. In case this is impossible (for example, in the country and in the practice of another physician), special instructions should be sent several days previously, in order that everything may be ready. The room chosen is to be cleared of all the ordinary furniture, carpets, and rugs; the floor and, if possible, the walls and ceiling should be thoroughly scrubbed with soap and water. All hangings are to be removed from the windows and doors, and special attention is to be given to the cleansing of the window-sills, of all corners and crevices, and of the wood-work generally. For the operating-table, an ordinary plain, narrow kitchen-table will answer every purpose. It should measure about three feet in length, thirty inches in height, and twenty-two inches in width. For the patient's feet to rest on, a plain wooden chair can be placed at the end of the table at such an angle that the back of the chair will be caught under the lower edge of the table. It will be necessary to have two other tables about the same size as the operating-table, on which the vessels which are to contain the instruments, ligatures, sponges, and other necessaries may be placed. When the same sort of tables as the operating-table cannot be obtained, any two small, narrow tables about the

house may be used for this purpose, provided that, after being thoroughly scrubbed with soap and water and bichloride solution, they are covered with sterile towels. Six perfectly plain wooden chairs should also be ready; plush or cane-seated chairs are not suitable for this purpose. The tables and the chairs should be thoroughly scrubbed with soap and water and mopped over with a one to five-hundred aqueous solution of bichloride of mercury. After this preparation they are not to be touched until the surgeon and his assistants arrive. There should be an abundant supply of hot and cold water, which, after being boiled, should be kept ready for use in perfectly sterile vessels. Special orders must be given about the cleansing of the large tin boilers in which the water is to be kept. They should be thoroughly scrubbed out with sand-soap and water and then well rinsed out with water. The water which is to be employed for washing the hands and instruments should be thoroughly boiled some hours previous to or even on the day before the operation. The supply vessels in the operating-room should be provided with lids, which should be covered with sterilized towels or some other clean material, in order to avoid the slightest risk of contamination from the dust of the room. On the day of the operation one of the boilers should be placed on the stove and a sufficient quantity of water made hot again. The water should remain under the supervision of an assistant, to whom the duty of attending to the bringing of it

to the operating-room should be delegated. It will not be safe to allow one of the members of the family or a servant to undertake this duty, as they might, from ignorance, be guilty of putting their hands into the pitcher, or in some other way might contaminate the water. Four or five perfectly clean china basins and pitchers, which have been thoroughly scrubbed out with soap and water and then rinsed out with one to five-hundred bichloride solution and plain hot water, will be needed to receive the hot and cold water, being afterwards covered with sterilized towels.

The *preparation of the patient* in a private house can be as thorough as in a hospital, and the methods already advised in Chapter IV. should be closely followed. Where possible, the surgeon will find it best to have two nurses, one who will attend to the preparation of the patient and will have the subsequent charge of the case, and a second to attend to the details of the operating-room and to assist at the operation itself. If the operation be in the country, the surgeon should always have at least one assistant with him, who has had the advantages of a practical training in modern methods, to aid him in the maintenance of an aseptic technique. This is particularly advisable for abdominal work; and if an untrained assistant is permitted to take any part in the operation, he must be thoroughly instructed as to what he is to do, and that he is to touch nothing unless especially told to do so. The nurse and the assistant should make as little noise as possible while arranging the room in which

the operation is to be performed. The assistant should allow himself at least two or three hours in which to make his preparations. When he arrives at the house, the nurse should be called, and she should at once show him to the room. He first proceeds to clean his hands, and then, having dressed himself in his uniform, begins his work. The tables and chairs are put in their places, the operating-table occupying a position near a window from which the greatest amount of light will be thrown upon the field of operation. Those on which the vessels containing the instruments and sponges are to be placed are arranged at a convenient distance from it. The sterile water, which has been boiled some hours previously and allowed to cool, must be ready. The hot water which is in the boilers on the kitchen stove should be transferred to the clean pitchers by means of a perfectly clean tin ladle with a long handle, the tops of the pitchers being immediately afterwards protected with a towel or a gauze hood, and strict orders being given that under no circumstances is any one to put his hand into the water or touch the mouth of the pitcher. I have not infrequently seen both nurses and doctors test the temperature by dipping their fingers into the water in the pitcher. This, of course, is an inconsistency, and should not be permitted.

After these preparations have been made, the assistant proceeds to wash his hands and forearms before getting the instruments ready. If, however, he wears the rubber gloves and rinses them well in a one to

five-hundred bichloride solution from time to time, it will not be necessary to give the hands the final scrubbing until later. The basins or trays, after being washed out with a one to five-hundred aqueous solution of bichloride of mercury and then with hot water, are now partially filled with the plain hot water and are ready to receive the instruments and ligatures. The artery forceps should all be placed in one tray, and the ligatures and needles in another, while a third is devoted to the scalpels and scissors with the dissecting forceps which are first used at the beginning of an operation. Two large basins half filled with plain sterile water should be provided, the first in which the sponges can be cleaned and the other in which they are kept. On the table nearest the operator should stand two basins filled with plain hot water, so that he may rinse his hands from time to time during the operation. There should be near at hand a vessel in which the diseased structures which are to be removed can be received. The assistant now takes off the rubber gloves and then thoroughly disinfects his hands. The gloves can be placed in the basin containing the bichloride solution and put on again if it is necessary for him to help to lift the patient on the table. The patient should not be anæsthetized until everything has been satisfactorily arranged, so that there may be no delay after she is once ready. It may be left to the assistant who has charge of making these preparations to say when the anæsthetic is to be administered, as he knows exactly how long it will take

to complete them. The operator should arrive at least fifteen minutes or half an hour before the time set for the operation, and should spend this time in changing his clothes and in cleansing his hands. A nurse or one of the assistants should be ready to change the water in the basins for him. The nurse generally remains with the patient while the anæsthetic is being administered. This is best given in a room away from the operating-room, as the patient will then not be disturbed by the noise or by the sight of the preparations. The anæsthetizer will require aid in carrying the patient to the operating-room and placing her in position on the table. If the other assistant surgeons help him to do this, they should wear rubber gloves and armlets.

The patient being on the table, the abdomen is first thoroughly cleansed in the manner previously described. This cleansing should be performed by one of the assistants who is well acquainted with the method which the operator employs for this purpose. While the abdomen is being prepared, the second assistant, who has been scrubbing his hands for the last time, should soak them thoroughly in the one to five-hundred bichloride solution for one or two minutes, and then rinse them off in the plain sterile salt solution or hot water just prior to the beginning of the operation. The abdomen having been rendered sterile and the field of operation being protected with the gauze and towels, the operator is ready to make the first incision.

If irrigation of the abdominal cavity is required, a pitcher which has been thoroughly sterilized should

be ready. The most convenient vessel for this is a glass jar, the so-called thermometer-jar, to which reference was made on page 132. If an ordinary pitcher is to be used, a sterilized thermometer is necessary in order to test the temperature of the water, as it will not be safe to trust to the impression given to the hand from the outside, and it will not be allowable to place the fingers in the water.

It requires a considerable length of time to arrange all the details that have been described, but if we hope to do an aseptic operation none of them can be neglected. Where, from the grave condition of the patient, it is necessary to operate immediately, of course it will be impossible for us to carry out all these details, but in any case we should attempt to follow them as closely as possible. Naturally, even where the most careful and elaborate preparations are made, there are many more chances for the wound to become contaminated than there would be in an operating-room especially set aside for the purpose. We must, however, never fail to pay strict attention to the details, since, though we may have good luck for a while, careless habits, once formed, cannot fail sooner or later to lead to bad results.

In doing plastic operations a rubber irrigating-bag filled with warm sterile water, suspended from a nail driven into the sash of the window, may be used, by means of which a steady stream can be directed upon the parts, thus doing away with the necessity for sponging. Not so much furniture will be required

for a plastic as for an abdominal operation. One table is generally sufficient for holding the vessels containing the instruments and ligatures. On a chair on the left-hand side of the operator a basin may be placed to receive the soiled instruments. These should never be allowed to touch his lap, unless it is protected by a piece of sterilized gauze or a sterilized towel. On another chair to the right of the operator may be placed a tray for holding the instruments that will be required throughout the operation. Not only does this simplify matters a good deal, but the instruments run less risk of becoming contaminated.

The after-care of cases has been outlined in Chapter XIII. If the operator lives too far away to make it possible for him to see the patient every day, he must of necessity intrust her to the care of a local physician, leaving with her, if possible, one of his own trained nurses. Before going away he must not omit to give full instructions regarding diet, catheterization, the administration of enemata, and the indications for changing the dressings, and to provide as far as possible against any emergency which may arise.

A detailed description of all the possible chances of error and of the many precautions which must be taken to meet them would require the writing of a whole book. In this chapter we have attempted merely to give an outline of the general course to be pursued, leaving it to the good sense of the surgeon himself to decide upon the precise steps to be taken when other emergencies arise.

CHAPTER XV.

ANÆSTHESIA AS AN AID TO DIAGNOSIS: ITS IMPORTANCE IN GENERAL SURGERY AND GYNÆCOLOGY—PREPARATION OF PATIENT—POSITION—METHODS OF EXAMINATION—RECTAL PALPATION.

WHEN making a physical examination of the abdomen in obscure cases where the existence of some deep-seated tumor or abscess, or, in fact, any pathological condition is suspected, it is often impossible under ordinary circumstances to obtain satisfactory results. Sometimes palpation is so painful that the patient cannot endure the slightest manipulation, and even when no pain is present, not only in nervous patients but in others as well, we find that as soon as the hands touch the abdomen, the muscles, more especially the recti, at once become so tense, in spite of all the patient's efforts to assist us, that it is impossible to feel anything which may be beneath them. Besides this we have to take into account the possibility of the existence of a so-called "phantom" tumor.

It is not now considered a serious matter to put a patient under the influence of an anæsthetic, and consequently, where after a preliminary examination a reasonable doubt still exists, it has become much more common to make a further examination under anæs-

thesia. In this way we not only spare the patient any unnecessary pain, but all the muscles of the body are relaxed, and thus the conditions most favorable for palpation are obtained. This aid to diagnosis, it is true, has not been sufficiently appreciated or employed often enough by surgeons; and even in many of the larger clinics of to-day this method is but rarely used. The advantages which it presents, I think, must be quite evident even in general surgery, but it is in gynæcological cases in which after a careful internal and external examination doubt still exists concerning the condition of the pelvic organs that the best results can be obtained by its employment. I shall therefore confine myself to speaking briefly of its use in gynæcological cases.

Without the administration of an anæsthetic it is impossible in the majority of cases to arrive at an absolutely correct idea of the condition of the pelvic organs. Of course, it should be the rule to examine first in the usual manner, but if doubt still exists as to the exact condition of the uterus and its appendages, this first examination should be supplemented by a second, during which the patient should be under complete narcosis. In this way mistaken diagnoses can often be corrected, and doubts can be cleared up. In the majority of instances small adherent tubes and ovaries cannot be definitely outlined until the patient is fully anæsthetized; not infrequently, on the other hand, cases come before us in which the clinical history has suggested the presence of pelvic inflammation,

so that we are predisposed to believe that an abnormal condition of the pelvic organs exists, which requires operative treatment, whereas an examination under anæsthesia will convince us that the structures are healthy, and that we must look for some other cause to explain the symptoms. Cases again in which the clinical history and the preliminary examination have suggested nothing, so that no serious pathological condition of the parts was suspected, have proved, when the patient was under complete anæsthesia, to be instances of adherent lateral structures.

In two hundred and forty cases which came under my charge, in each of which two examinations were made, one in the ordinary way and the second with the patient under complete anæsthesia, precisely similar results as to the condition of the adnexa were obtained from the two examinations in only eleven cases. In fifty-one cases, even after complete narcosis, the adnexa of both sides could not be definitely outlined. It was possible to make a diagnosis in one hundred and eighty-one minor cases and in fifty-nine abdominal cases.

While it is true that it is often possible to palpate the pelvic organs in women who have borne children without the use of an anæsthetic, this rule is by no means without exceptions, and in a number of cases, which have been examined, even under complete anæsthesia it was not possible to state definitely that the uterine appendages were free from disease.

Any one who has had much experience in the ex-

amination of cases under anæsthesia has no doubt found this to be true in a certain proportion of cases, and the statement not infrequently made that a skilled gynæcologist should always be able to determine whether disease of the pelvic organs exists by an examination under anæsthesia must be considered incorrect.

Although, however, we cannot in every case make a certain diagnosis, yet it is evident that such examinations, if carefully made, will certainly diminish the number of exploratory incisions. This by itself would be a decided gain, as every operator knows that such procedures are not entirely free from danger, and are often much dreaded by the patient. In many cases also, patients will not be subjected to unnecessary operative measures, while, on the other hand, many will be restored to health by the early recognition of the existence and by the removal of diseased structures. Even in cases where an abnormal condition of the pelvic organs calling for operation is known to be present, it is often of great importance that the surgeon should before operating have as complete information as possible about the existing lesions. Thus an examination under anæsthesia would in some cases show beforehand the probable value of an operation, and since the danger is so slight I believe that such a preliminary examination should be employed unless any clear contra-indication is known to exist.

It should be a practice, then, after the history of the patient has been taken, to examine the pelvic organs

in the usual manner. If the structures cannot be satisfactorily outlined, an examination under anæsthesia should be advised, after which a rational mode of treatment can be outlined. Where disease of the pelvic organs has been suspected and nothing abnormal is detected, the patient will be relieved of any anxiety which she may have felt in regard to her condition. At the same time the physician can satisfy himself as to the necessity for, or the disadvantages of, an immediate operation, and much of the routine treatment, which is to a great extent empirical, may then be omitted. We can also with good conscience dispense with the prescribing of the multitude of drugs which have been so highly vaunted for imaginary pathological conditions of the pelvic structures, and trust rather to hygienic measures, or, in case it is necessary, proceed at once to an operation.

I shall now speak more in detail of the methods to be employed in making an examination under anæsthesia.

In preparing a patient for the examination, the following rules are to be observed. The alimentary canal should contain as little food as possible, so that it is well to have the bowels of the patient well opened the day before, and again on the morning of the examination. The patient's diet the night preceding should be light, and the breakfast on the day of examination should consist of a glass of milk or a cup of tea or coffee. If, however, the patient can be induced to do without even this, there will be less nausea

and vomiting subsequent to the anæsthesia. The anæsthetic is generally administered about two or three hours after the breakfast hour. The clothing of the patient should consist of a light wrapper or night-dress, which should be so arranged that it will not hinder the examiner. Complete anæsthesia is necessary, as it is often impossible to palpate the structures thoroughly if there is the slightest resistance. Again, the diagnosis must not be made from the first impression that one gets of the condition of the structures when making an examination under complete anæsthesia, for often that which at first seems to be an unusual condition of the pelvic organs is found, after a more thorough examination, to be normal. For these reasons anæsthetics which act quickly and have but a transitory effect should not be used.

The position of the patient is of great importance. During the examination she should lie across the mattress or on a table, so that the buttocks rest on one edge, the legs being separated and flexed on the thighs, which are in turn flexed on the abdomen. In this position the abdominal walls are well relaxed. If it is impossible to have the legs supported by assistants, the leg-holder can be employed. After the patient has been placed in position, a sheet is arranged over the lower extremities so that they are covered. Plate XXIII. The external genitalia are first inspected. It is best to adopt a certain order in the examination. Beginning with the vagina, and passing thence

PLATE XXIII.

Examination under sheet.

to the cervix, one next endeavors to palpate the uterus and its appendages, and afterwards the ureters. The urine having been drawn off with a sterile glass catheter, the index finger or, more commonly, the index and the middle finger, previously anointed with vaseline, are introduced just within the vulva, and we endeavor to ascertain whether any laceration or cicatricial tissue exists at the orifice or along the vaginal wall. The hand is then turned so that the palmar surfaces of the examining fingers come in contact with the anterior vaginal wall. The lateral walls and fornices are next examined, and the existence in the vagina of any viscid or abnormal secretion is noted. We next come to the cervix, and note (1) the position which it occupies with relation to the axis of the vagina; (2) its shape and consistence, whether it is conical or flattened, soft or hard; (3) whether it is lacerated, and the extent of such lacerations if they exist; (4) whether there is any eversion of the lips. The bimanual method of examining the uterus and its appendages is the most satisfactory. The operator places his right hand on the abdominal wall of the patient midway between the umbilicus and the symphysis pubis, his forearm being flexed at the elbow, the fingers (with the nails cut close) extended, the hand slightly flexed at the wrist-joint. Pressure should be made obliquely downward in a line running towards the tip of the coccyx, thus avoiding the intestines as much as possible. The hand in the vagina is now gently but firmly pushed upward towards the

hand on the abdominal wall, in order to palpate the structures which are being depressed by the external hand. If the appendages are difficult to palpate, and the uterus is in retroposition but not adherent, the examination may be facilitated by bringing the uterus forward. If the uterus will not stay in anteposition without support, it can be kept in this position by pushing it towards the symphysis pubis with the fingers of the abdominal hand. Starting from the uterus, one passes gradually to the side, making deep pressure with the fingers on the abdomen, and allowing them slowly to rise again, making the fingers in the vagina follow as closely as possible the fingers of the other hand as they move. In this way each portion of the broad ligament is passed between the fingers, so that there is less likelihood of missing the ovaries, or of overlooking any abnormality that may exist connected with the appendages of the uterus.

The mere palpation of the adnexa in itself is not of very great service. In order to make a definite diagnosis, each structure must be definitely and precisely outlined before we can be certain of the presence or absence of pathological conditions.

If a satisfactory examination cannot be made by the combined vaginal and abdominal manipulation, then palpation by the rectum may be employed, either alone or in combination with the abdominal and vaginal touch. The examination is made by introducing the first or second finger of the left hand into the rectum; often, however, both are employed. If one finger

only is introduced into the rectum, the other may be inserted into the vagina, while the fingers of the other hand press the abdominal wall obliquely downward.

Immediately after the examination the patient is given a vaginal douche of a litre of a warm aqueous two-per-cent. solution of carbolic acid. As soon as she recovers from the effects of the anæsthetic, she is allowed to return home, but is advised to remain in bed for at least two or three days. Of course great care must be taken during the examination never to handle the structures roughly, as a cyst or other sac, if present, is liable to be ruptured, and a fatal result might possibly ensue.

CHAPTER XVI.

BACTERIOLOGICAL AND CLINICAL EXAMINATIONS IN SURGERY AND GYNÆCOLOGY.

It has already been stated that the principles underlying the technique which modern surgeons employ are based upon the brilliant results of bacteriological investigation. The importance of a practical acquaintance with the methods of bacteriology has also been fully insisted upon. Although for an intelligent knowledge of these methods the text-books devoted especially to this science must be consulted, it has nevertheless been thought worth while to devote a few paragraphs here to the subject of the outfit which will be required for the ordinary work of the investigating surgeon, and at the same time to refer briefly to some practical points which may be of service.

To become the owner of all the apparatus described in the books as necessary for bacteriological work would of course be beyond the power of most surgeons, and indeed all the items are by no means necessary. It is surprising what an amount of good bacteriological work can be done with a very meagre outfit,—a thermostat, a sterilizer, a microscope with an oil immersion lens, a few test-tubes, and a small quantity of platinum wire.

A good microscope with an Abbe condenser and

immersion lens is indispensable. The supply of culture media kept on hand need not be large. Tubes of agar-agar and gelatin will be most necessary, while a few of bouillon, blood-serum, potato, milk, and lactose-agar will be convenient at times in differentiating bacteria. The surgeon or the assistant who does the bacteriological work should himself assume the responsibility of the preparation and sterilization of the media. If this is neglected, of course no reliance can be placed on the results. The hot-air sterilizer and the thermostat (kept by the thermo-regulator at 37° C.) need not be large. For ordinary work a gelatin thermostat (at 22° C.) may be dispensed with, and gelatin plates may be allowed to grow out at the room temperature. For the making of plates the Petri dishes are very convenient and are now not expensive. In case, however, they are not at hand, the "Esmarch plates" may be made by rolling the inoculated tubes on a block of ice.

In making bacteriological examinations a certain definite routine should be followed. In the first place smear cover-slip preparations should be made from the material to be examined. These should be dried, fixed in the flame, and stained with one of the ordinary bacterial dyes (anilin oil gentian-violet, carbol-fuchsin, or Löffler's methylene blue). The study of these will give an idea of the varieties and number of micro-organisms present. At the same time plate cultures should be made, usually with dilutions, and the different varieties, if more than one be present,

should afterwards be isolated in pure culture. Each variety is then carefully studied as to its morphological and cultural characteristics, and if necessary by inoculation into animals. The identification of micro-organisms is often tedious and difficult, and the work should, where possible, be done under the control of an experienced bacteriologist. The growing of the organism on the different kinds of culture media, the examination for motility, the enumeration of the flagella in specimens stained especially to demonstrate them, and the determination of spore formation are points which should not be neglected where such precision is necessary. The animals best suited for bacteriological tests are mice, rabbits, and guinea-pigs. The first are preferably inoculated subcutaneously at the root of the tail; in the case of rabbits and guinea-pigs the material to be experimented with may be placed either under the skin or into the peritoneal cavity, while in the case of the former intravenous injections are also sometimes employed. When an animal has died from an experimental infection a careful autopsy should be made upon it; the gross appearances of the various organs should be noted, and frozen sections, cover-slip preparations, and plate cultures should also be made from them, the report of such examinations being recorded in neatly kept protocols. Most of the anaërobic bacteria can now be easily cultivated, since Buchner's jars have been introduced. Such bacteriological work when carefully done is sometimes of the greatest value, but when per-

formed in a careless or slipshod way is likely to do far more harm than good.

Bacteriological examinations are often very helpful in diagnosis; thus, for example, gonorrhœa and tuberculosis may often be diagnosed from the cover-slip preparations of the discharge alone. Instead of making the ordinary cover-slip preparations, a very convenient method consists of smearing the material directly over a large area of a glass slide. After the preparation has been allowed to dry in the air the slide is passed through the flame, and the staining is then done in the ordinary way. The excess of stain having been washed off, the slide is dried between folds of blotting-paper. A drop of oil is then placed directly upon the smear, no cover-glass being employed, and the preparation is examined immediately. The same method may be employed where it is necessary to examine several different specimens at one time, the smears being made at different spots on the same glass slide and all stained at once.

Culture media, platinum needles, and clean cover-slips should always be ready in the operating-room, so that everything shall be on hand in case at an operation it should be desirable to make cultures from an abscess or from the contents of a cyst.

In the controlling of the disinfection of the skin, and of the methods employed for the sterilization of suture materials and dressings, methods of procedure similar to these just described should be resorted to. It is, of course, to be remembered that, where the

germicidal effect of chemical solutions—as, for example, in dealing with the disinfection of the skin—is being tested, care is to be taken that none of the chemical substance is carried over into the culture medium, or the whole experiment will be vitiated. The erroneous conclusions previously held in regard to the disinfectant power of corrosive sublimate had their origin in faulty technique.

At an autopsy on a patient who has died after an operation a thorough bacteriological examination should be made, for it is only in this way that any adequate conception is to be gained of the peculiar forms which infections can assume. Here, too, cover-slip preparations and cultures are to be made from the organs, and animals are to be inoculated with portions of the tissues. This triple precaution might at first seem unnecessary, but often one method will succeed when others fail. Thus not infrequently the number of micro-organisms present is so small that they are not seen in the examination of smear cover-slip preparations, and yet a few colonies may nevertheless grow out in the plate cultures. Again, in the case of an organism like the micrococcus lanceolatus, which may be hindered from developing in the tubes from some slight fault in the culture media, it might perhaps be isolated with ease from the blood of a susceptible animal which had been inoculated with a piece of the tissue containing it. On the other hand, where the organisms are already dead, as not infrequently happens in old-standing pelvic abscesses, cultural methods

and inoculation experiments would of course fail to demonstrate the presence of any bacteria at all, while simple cover-slip preparations will often show the dead bacteria. Finally the staining of tissues, which have been hardened in absolute alcohol, according to the method of Gram as modified by Weigert, or with methylene blue and eosin, should be resorted to as still another method of control.

More will be said later upon the examination of tissues from a pathological stand-point.

Clinical Examinations.—It is not necessary to offer an apology here for insisting on the importance in surgical and gynæcological cases of making thorough clinical examinations. The specialist to be successful in the truest sense of the word must be a man who has first laid a broad foundation of general medical knowledge before attempting to devote himself more exclusively to the study of the diseases of some special part of the body. But the rank and file of the specialists of to-day number among them very many who, seeking a royal road to knowledge and perchance to fortune, have thought to build a durable superstructure upon a flimsy basis. Much of the opprobrium against specialism is attributable to the narrowness of such men who have never striven to gain a varied clinical and pathological experience, and consequently are entirely lacking in the unbiased judgment which such a training alone can bring. The uterus and the ovaries, like the eye, the nose, and the throat, are only parts of the organism.

The gynæcologist who blames his fellow practitioner for diagnosing a case of salpingitis as one of typhoid fever has perhaps not examined the urine of a patient suffering from a diabetic pruritus whom he is himself treating.

The gynæcologist should be a well-trained clinician, and, while he cannot perhaps be expected to keep abreast of the general medical literature, he should at least be well acquainted with all those conditions which are not infrequently associated with disturbances of the female genital organs. And in order to be able to exclude serious organic disease in his patients and to guard himself against resorting to a serious operation upon an individual whose general condition, if it were recognized, would forbid such a procedure, he will take pains to secure a thorough training in general medical and surgical diagnosis. The importance of examining into the state of the emunctories in surgical cases is recognized by all, and skill in the different physical, chemical, and microscopical manipulations necessary is essential.

The urine in every case—certainly in those which require operation—should be carefully studied, and records kept as to the color, odor, reaction, specific gravity, and the presence or absence of albumen, sugar, or bile. The sediment collected by allowing the specimen of urine to stand for some time in a conical glass (or more quickly by centrifugalization) should be examined microscopically, and the occurrence in it of any casts, cylindroids, crystals, cells, or

other substances should be noted. In special cases it may be desirable to determine the toxicity of the urine. Where pyuria exists the pus should be examined bacteriologically.

The examination of the blood by the newer hæmatological methods will often throw light on obscure cases in surgical and gynæcological practice. By this we mean not simply the noting of the general characteristics, but a fuller and more complete examination,—the careful study of the "fresh-blood slide," the estimation of the hæmoglobin, the counting of the red and white elements, and the study of specimens dried and stained according to the methods of Ehrlich. The relation of chlorosis to menstrual troubles has long been known and taught, but there is probably no more common mistake made than to treat locally the amenorrhœa of chlorosis instead of attempting to improve the blood condition.

The presence or absence of an acute leucocytosis in the blood has often been found of great importance in the diagnosis of inflammatory and suppurative conditions within the pelvis as well as elsewhere in the body. The ready way in which the existence of a malarial infection may be recognized or disproved by the examination of specimens of fresh blood cannot fail to be of service in differential diagnosis. Undoubtedly patients suffering from genuine chronic malaria have before now gone the rounds of the specialists and submitted to varied local treatment without avail, while on the other hand it is to be

feared that more than once a localized abscess with its chills and intermittent fever has been classed as a case of malarial fever by the medical attendant.

The study of the sputum, too, will often prove a valuable aid. The importance of the early recognition of pulmonary tuberculosis can hardly be overestimated, and, strange as it may seem, this task often falls within the province of the gynæcologist, for it is to him that these patients frequently come first, complaining of weakness, disinclination for exertion, amenorrhœa, or other menstrual irregularities.

The giving of a test breakfast and the abstraction and subsequent examination of the stomach contents may give valuable indications not for diagnosis alone, but also for treatment. The enormous strides made of late years in these chemical examinations and the clinical deductions which may be drawn from them are fully appreciated by the teachers of modern internal medicine, and there is no reason why surgical and gynæcological patients should be denied these benefits. In all cases in which there are symptoms referable to the stomach and in which the passing of a tube is not contraindicated, a test breakfast should be given and the stomach contents studied. The quantity, reaction, and appearance should be noted, the total acidity estimated by titration, the presence or absence of free acid demonstrated with Congo red, and of free hydrochloric acid by means of the phloroglucin-vanillin reaction. Besides this, the presence or absence of the lab-ferment (by the fresh milk test),

of lactic acid or lactates (by Uffelmann's test), and the activity of the digestive power on egg albumen should be determined. In some instances additional points of value in the differential diagnosis of abdominal tumors may be gained by the electrical illumination of the stomach.

The chemical and microscopical examination of the fæces, too, will often help us in the management of difficult cases.

The importance of paying close attention to the primæ viæ in all surgical cases cannot be too much insisted upon. In healthy digestion and normal absorption lie the main secrets of that shadowy "resistance" about which we talk so much and know so little. Our more recent knowledge upon the subject of the auto-intoxications and auto-infections from the gastro-intestinal tract must be constantly borne in mind and applied by every surgeon who would have his wounds do well.

Other things being equal, that surgeon will make fewest mistakes and obtain the best results who knows how to utilize to the utmost the knowledge and technical methods of all departments of medical science.

CHAPTER XVII.

THE EXAMINATION OF THE INTERIOR OF THE FEMALE BLADDER, AND THE CATHETERIZATION OF THE URETERS.

UNTIL recently a lack of convenient and satisfactory methods for the examination of the interior of the bladder has impeded the progress of vesical and ureteral therapy. The older ways of inquiring into diseased conditions of the more remote portions of the urinary passages were wholly inadequate. The cystoscope of Nitze and Leiter, and the endoscope of Grünfeld, while affording, indeed, to a trained specialist a view of a part of the bladder at one time, were entirely unsuitable for use in general practice; and the catheterization of the ureters, as recommended by Simon and subsequently by Pawlik, was too complicated a procedure to permit of more than a very limited application. General practitioners, and, perhaps, the majority of specialists, were content to base their diagnosis, prognosis, and treatment upon conclusions drawn from the subjective symptoms of the patient supplemented by the results of a careful examination of the urine. Fortunately, Dr. Kelly* and others have so extended and at the same time have so simplified the technique of the examination of the

* The American Journal of Obstetrics, 1894, vol. xxix., No. 1.

bladder and ureters that the field is practically open to all, and there seems to be no reason why the methods which without the use of complicated apparatus permit of direct visual inspection of the whole female bladder and ureteral orifices, and which render it possible to complete the catheterization of both ureters within a few seconds after the introduction of the speculum, should not, like laryngoscopy and ophthalmoscopy, be taught to students in every medical school.

The following instruments and accessories are required for the examination: One female catheter of small calibre; a urethral calibrator graduated in millimetres; a series of urethral dilators; a series of specula with obturators; an ordinary head-mirror with some artificial light, best supplied by an Argand burner or an electric lamp; one pair of long, delicate mouse-toothed forceps; a suction apparatus for completely emptying the bladder; a ureteral searcher; a ureteral catheter without a handle (Figs. 41, 42, 43, 44); several hard pillows or bags filled with bran, or an inclined plane for elevating the pelvis.

The patient is first catheterized, a specimen of the urine from the bladder being preserved for comparison with that which is to be taken directly from the ureter later on. The size of the external meatus having been determined by the calibrator, the dilator of the corresponding size is first introduced, and is followed in turn by the larger ones of the series until the urethra is dilated to a diameter of from twelve to fifteen millimetres, or a little more than half an inch.

FIG. 41.

Double urethral dilator.

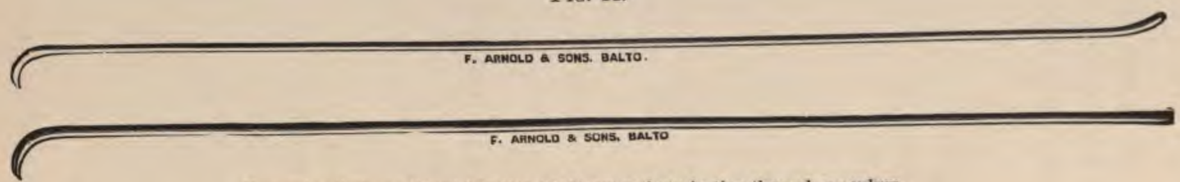
FIG. 42.

Speculum and obturator (⅔ natural size).

Fig. 43.

Delicate mouse-toothed forceps (¾ natural size).

Fig. 44.



Ureteral catheters without handles, for direct catheterization through speculum.

The necessary degree of dilatation can usually be completed without more than a slight external rupture, and when it has been reached a speculum of the same size as the last dilator is introduced and the obturator belonging to it is removed. By means of cushions, bran-bags, or an inclined plane introduced beneath the hips of the patient, the pelvis is elevated from eight to sixteen inches above the level of the table. Plate XXIV. The examination is made with the aid of the head-mirror and artificial light. A candle in a dark room suffices if no other light is available. The obturator being withdrawn from the speculum, the bladder immediately becomes distended with air, and by properly directing the reflected light it becomes possible to examine every portion of it. There is usually, even after the most careful catheterization, a little residual urine, which can be removed by the suction apparatus, or, if the amount be trifling, by means of little balls of absorbent cotton held in the long mouse-toothed forceps. After a little practice on the normal bladder, the operator becomes acquainted with the distribution of blood-vessels in the mucous membrane, and with certain landmarks which enable him to recognize without difficulty the sites of the ureteral orifices. Thus, on elevating the handle of the speculum, so that the base of the bladder comes into view, the region of the inter-ureteric ligament becomes visible. This is often to be distinguished by a slightly elevated transverse fold or by the difference in color of the mucous membrane of that region. After this

PLATE XXIV.

Hips in *moderate* elevation for cystoscopic examination and direct catheterization of ureters. Cystoscopic and ureteral instruments on tray in foreground.

landmark has been found, the ureteral orifice on either side may be discovered by turning the speculum laterally through an angle of some thirty degrees, and looking sharply. Under normal conditions little jets of urine may sometimes be seen coming from the orifice, and in some pathological cases pus or blood can be detected as it trickles from it into the bladder. The appearance of the ureteral orifice varies considerably. It may look like a dimple or a little pit in the mucous membrane, while at other times it resembles an inverted V lying obliquely with the apex pointing outward and a little upward. In cases in which there has been inflammation it may present the appearance of a small round hole in a cushioned eminence. In some instances when it is difficult to see it at all its situation may be easily recognized by watching for the escape of fluid from it. The ureteral orifice examined directly in this way appears to be nearer the urethra than it really is, owing to the illusion produced by the foreshortening of the base of the bladder. Dr. Kelly suggests the following as a valuable aid to the beginner where there is any difficulty in discovering the orifice. "A point is marked on the cystoscope at a distance of five and a half centimetres from the vesical end, and from this point two diverging lines are drawn towards the handle, with an angle of sixty degrees between them. The speculum is introduced up to the point of the V, and turned to the right or left until one side of the V is in a line with the axis of the body.

Then by elevating the endoscope until it touches the floor of the bladder, the ureteral orifice will nearly always be within the area covered by the orifice of the speculum."

The searcher (a long, delicate sound with the handle bent at an angle of 120°) is next employed, and if what has been seen is really the orifice, it will at once pass readily for a distance of from two to six centimetres into the ureter. The ureteral catheter may then be immediately substituted for the searcher and the urine can be collected as it is passed from the kidney.

The genu-facial posture possesses advantages in some cases, especially where chronic inflammatory thickening of its walls hinders the distention of the bladder with air while the patient occupies the ordinary position. In nervous women, or in especially difficult cases, the examination should be made under anæsthesia, but ordinarily, and especially after the surgeon has acquired the necessary skill in the manipulations, a general anæsthetic is not needed, a little cocaine applied to the urethra five or ten minutes beforehand being usually sufficient to prevent pain.

A flood of new light has been shed upon the diseases of the bladder and ureters by these new methods of examination. No matter how much the surgeon may have read about the appearance of pathological conditions of the bladder-wall, he cannot fully appreciate the character of the phenomena produced by disease until he has seen them as they actually appear to the eye during the life of the patient.

The bane of gynæcologists, the so-called "irritable bladder," can now be thoroughly studied, and in many cases this unsatisfactory diagnosis can be exchanged for one which is descriptive of some definite pathological lesion, which with our present methods can be satisfactorily treated. In cases of cystitis the involvement of the entire wall of the bladder is the exception rather than the rule, and very often all the symptoms are due to a single patch, or to a small number of diseased areas. The exact localization of these foci and their treatment by topical applications is now a matter of no difficulty, and under such conditions it certainly is no longer justifiable to inject into the bladder strong caustics which will undoubtedly injure the mucous membrane which has remained healthy.

The application of the method of examination just outlined to cases of stone, neoplasm, fistula, tuberculous ulceration, etc., is so obvious that it need not be discussed at length here.

In other cases an advantage of quite a different kind can be gained by the introduction of catheters or bougies into the ureter. In certain operations, such, for example, as a hysterectomy for carcinoma of the cervix and some hysteromyomectomies, it is important that the operator should be quite certain of the exact location of the ureters. The accident of tying, tearing, or cutting the ureters has happened to many operators, and the making of a uretero-ureteral anastomosis, the transplantation of the ureter into the

rectum, vagina, or bladder, or even the removal of the kidney which was involved, did not always prevent a fatal result. If bougies be introduced into the ureters and pushed up over the brim of the pelvis towards the kidney, the ureters may be distinctly felt as hard cords and avoided throughout the operation.

But sometimes it may be desirable to catheterize the ureter without the preliminary dilatation of the urethra. To do this the patient is placed on the table with the buttocks close to the edge and with the legs flexed upon the abdomen. The urine from the bladder having been drawn off, the situation of each ureter as it enters the bladder is made out according to the method suggested by Sänger,—by palpation through the anterior vaginal wall. A speculum is next used to retract the posterior vaginal wall, so that the anterior wall of the vagina as far as the cervix may be watched while a sterile solution of methylene blue is injected into the bladder. When the bladder has been sufficiently distended (150–200 c.c. of the solution are usually sufficient for this purpose), the catheter with metal plug inserted in its outer end is introduced into the bladder and a search is made for the ureteral orifice. One has to be guided in this search chiefly by the sense of touch, although some aid can be obtained from watching the situation of the point of the instrument as far as it is possible to do so through the anterior vaginal wall. When the point of the catheter comes in contact with the ureteral eminence, it may be felt to give a distinct "trip," and

the sensation of a slight jar will be conveyed to the thumb and finger in which it is held. After one or two attempts the tip of the catheter becomes engaged in the orifice of the ureter, after which it will not be difficult to pass it well up. The plug is then removed from the outer end and the urine is collected. If it is unmixed with methylene-blue solution there can, of course, be no doubt that the catheter is in the ureter. A second catheter may, if desired, be passed into the ureter on the opposite side. There is, perhaps, no more satisfactory clinical test than to see pus trickling from one ureteral catheter while clear urine is at the same time running from the other. This method of working "in the dark" is, of course, much less satisfactory, and requires more skill and training than the one first described, and indeed the easier method will meet the requirements of nearly every case.

Catheterization of the ureters in the male is a far more difficult procedure, and in those cases which do not permit of a satisfactory cystoscopic examination on account of marked intravesical enlargement of the prostate may be regarded as impossible. In 1894 the late Dr. James Brown, of Baltimore, was successful in several cases. He employed a modification of the Nitze-Leiter cystoscope suggested by Dr. Brenner, who, however, was not able to catheterize the male ureter. The results of this method have proved highly satisfactory, and as a result of improvements in our methods and technique the procedure has now come into more general use.

CHAPTER XVIII.

PATHOLOGICAL EXAMINATIONS.

A KNOWLEDGE of pathology acquired from the study of text-books alone will be found of comparatively little use in practice. Histology, pathology, and bacteriology can be learned only in the laboratory, and a surgeon who has studied under the microscope only those specimens which have been prepared for him by others, and who has not actually handled the fresh tissues and practised the methods of preparing them for microscopic examination will find himself wofully deficient when he is thrown upon his own resources. It is true that a busy surgeon may sometimes be compelled to delegate the mechanical part of the work to an assistant or to a colleague who devotes his time especially to pathology, but unless he has himself served an apprenticeship in this kind of work, he will be unable properly to appreciate what is done for him or make the best use of the results in the management of his cases.

In the best surgical clinics it is now a part of the regular routine to make microscopical examinations in some of the more difficult cases, before, during, and after the operation. Such examinations may be made primarily for clinical purposes and as an aid to diagnosis or prognosis in some particular case. But look-

ing at the subject from another stand-point it will readily be seen that any one who has learned how to utilize the material which comes from surgical operating-rooms will find that it serves admirably for purposes of research, inasmuch as the tissues may be placed immediately after removal from the living body into fixing reagents, thus yielding preparations far more desirable for study than can ever be obtained at autopsies. Any surgeon who will systematically examine by the various known methods specimens from all parts removed at his operations and make careful notes of what he finds in them, will soon have accumulated a mass of information, a study of which cannot fail to be of use to him in directing and controlling his subsequent work. The waste of the amount of interesting material which is thrown away from the larger operating-rooms in the course of a year is indeed to be deprecated when one thinks of the advances in our knowledge which might result if even a small proportion of it were carefully worked up.

Examinations of Tissues for Diagnosis.—Even in the practice of the best-trained men there will often occur cases in which some doubt exists as to the exact nature of a lesion, and in which it is often desirable, in order to decide upon the nature of the operation required, to determine definitely the character of the pathological changes which have taken place. The examination of a small portion of tissue cut out for this purpose or of the parts removed at a preliminary operation will

often throw much light upon the subject. In such cases the surgeon will be guided not alone by the macroscopic appearance of the tissue, but also by the study under the microscope of sections of the fresh unhardened tissue and of stained preparations made after the specimen has been fixed and hardened. Too much attention cannot be paid to the gross appearances of the tissues. The trained eye is sometimes able from these alone, not only to decide with some degree of certainty what is the probable nature of a given tumor, whether, for example, it is cancerous or not, but also to prophesy more or less accurately as to the particular type of growth present in the specimen under consideration. The color, the consistence, the translucency, the appearance on section, the juiciness, the vascularity, the presence or absence of areas of necrosis or of fatty degeneration will all be aids to diagnosis. It is not often, however, that the naked-eye examination is positively conclusive, and where there is any doubt at all we should not rely on this alone, since the study of fresh sections will in the vast majority of cases, to a good observer, decide the diagnosis definitely, and the ease and quickness with which such microscopic examinations can be made on the spot make it worth while to have the means of carrying them out in a room adjoining the operating-room, so that during an operation a bit of tissue can be examined immediately, and the further course of the operation be determined by the results obtained. The fresh sections may be made with a double knife (Valentine's knife) or by

means of a small ether-freezing microtome, which perhaps is more suitable for general work. These sections may be examined immediately in physiological salt solution, or they may be first stained (without previous hardening) in Carnoy's solution or with methylene blue dissolved in salt solution. Of course a certain amount of practice is necessary in order to make use of this method of examination, but the time spent in acquiring the requisite skill is by no means wasted. It is often possible in this way to diagnose cancerous or tuberculous tissue within five minutes after its removal from the body. Where there is no necessity for haste, the tissues may be dropped into fixing solutions and taken to the laboratory for thorough examination. But even in these cases portions of the specimen should always be examined fresh in salt solution, since certain changes (*e.g.*, fatty degeneration) can be made out most satisfactorily by this method. For fixing and hardening specimens strong alcohol or a ten-per-cent. solution of formal will be found satisfactory for ordinary work. The pieces placed in the hardening fluid should be as small as they can be conveniently made without injuring the specimen, since it may sometimes happen that when they are of too great a size the central portions may not be reached at all by the hardening agent. After being hardened the tissues are transferred to absolute alcohol for twenty-four hours, and are subsequently passed in the ordinary way through a mixture of absolute alcohol and ether into thin celloidin, where they remain

for from twelve to twenty-four hours. They are then transferred to thick celloidin for the same time, and after being embedded (in celloidin) on cork or on pieces of wood, and being allowed to remain for a few hours in eighty-per-cent. alcohol, they are ready to be cut into sections. Each microscopist has his preferences for staining dyes, but hæmatoxylin or methylene-blue, and eosin, or alum-cochineal will be found satisfactory for routine work. For a more minute study than that usually required for ordinary diagnosis (*e.g.*, the study of karyokinesis in neoplasms) very small pieces may be fixed in a seven-per-cent. solution of sublimate in salt solution for half an hour, and afterwards hardened in graded alcohols. Still more satisfactory results may be obtained by the use of Flemming's solution or Hermann's fluid. If sections be cut from small pieces of tumors which have been fixed in these fluids, subsequently hardened in alcohol, and embedded in paraffin, and these sections be stained on the slide (being fixed by means of Mayer's albumen) with safranin, or gentian violet, they will show exquisite mitoses (nuclear figures). In fact these are the measures now used by histologists for research work in this direction. It has been thought advisable to give here a few of the methods which are most commonly employed, and which have been found reliable; detailed directions on this subject will be found in the text-books on histological technique.

When a search is to be made for bacteria in the tissues, they should be hardened in absolute alcohol,

PLATE XXV.

FIG. 1.—Normal mucous membrane of the uterus. (After Zweifel.)

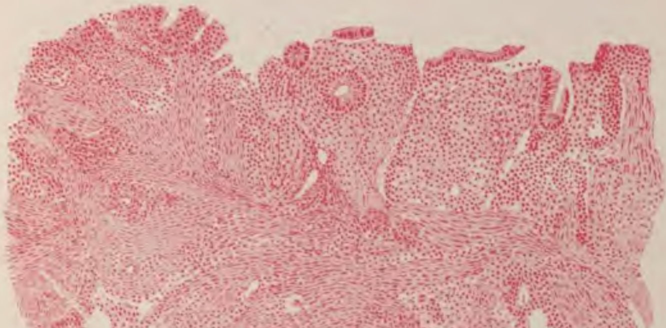


FIG. 2.—Chronic interstitial endometritis. (After Zweifel.)

embedded in celloidin, stained with Weigert's fibrin stain or with Löffler's or Kühne's methylene blue, and studied with an immersion lens.

The Examination of Scrapings from the Uterus.—Many contradictory opinions exist as to the value of the conclusions regarding pathological conditions within the uterus which can be deduced from a microscopic study of scrapings from this organ. While some authorities have laid too much stress upon the reliability of the results to be obtained in this way, others consider them to be totally without value. As usual, the truth seems to lie between the two extremes, and the best observers seem now to be agreed that, when taken in conjunction with thorough physical examinations and a careful analysis of the symptoms of which the patient complains, a microscopic study of the tissues obtained from the uterus will often aid us in arriving at a definite diagnosis. It is often extremely important to examine a few millimetres of the uterine muscle which lies immediately beneath the mucous membrane of the affected part, and, since in the operation of curetting one does not usually go to a sufficient depth for this purpose, it is often advisable to cut out a piece from the diseased region with a knife in order to make sure of securing a portion of the tissue which we desire to examine.

If portions of the uterine mucous membrane be embedded in celloidin the sections must not be passed through fluids, such as alcohol or oil of cloves, which will remove the celloidin; otherwise on account of its

delicacy some of the tissue will be carried away with it. Some prefer to stain the pieces in bulk, and to embed in paraffin. If this is done and if the sections are securely fastened to the slide by means of Schallibaum's collodion, Mayer's albumen, or Gulland's water method, before the paraffin is removed, we may feel perfectly sure that no part of the tissue, not even a single cell, will be lost or displaced. But for ordinary work the celloidin method will be found most convenient, and if ninety-five per cent. alcohol be used for dehydrating them, and oil of bergamot or creosote for clearing them, there will be no danger of mutilating the sections.

To appreciate the pathological changes which have taken place, it is of course necessary to have examined a large number of specimens made from the normal uterine mucosa. But in order to keep in mind the finer changes it is also desirable to have always at hand for comparison a number of sections of normal tissue taken from different cases. With this method of control one can more safely judge of an increase in the number of the glands, of variations in their size, shape, or arrangement, and of alterations in the interglandular stroma. Plate XXV., Figs. 1 and 2. After a little practice it will be possible to recognize the different forms of endometritis, from the acute septic variety, with necrosis of the mucous membrane due to infection with pyogenic bacteria, to the most chronic forms, characterized by atrophy of the mucosa and new growth of connective tissue, or any of the intermediate varieties, whether they are acute, subacute, or chronic. In

many cases no striking alterations in the mucosa are found. One of the most important facts which these microscopic examinations, when employed in conjunction with palpation and visual examination of the interior of the uterus, have taught us, is, that definitely localized lesions of the mucous membrane of the uterus can exist, and that in many of the so-called cases of endometritis the whole mucous membrane is not uniformly affected, but the disease is limited to certain well-defined areas, and often indeed is secondary to other conditions, such, for example, as a small polpyus, or to a myoma in the wall of the uterus.

The finding of chorionic villi in scrapings made after a hemorrhage from the uterus has taken place, with no apparent reason to account for it, will sometimes give a clue to the cause of the bleeding, which has, perhaps, been unsuspected not only by the physician, but also by the patient. The appearance of the villi when seen is sufficiently characteristic, but, as in some cases they are not numerous, careful search should be made through different sections, when an abortion is suspected, before deciding that they are not present. Fig. 45.

The surgeon is, however, most frequently called upon to decide from his examination of pieces removed from the uterus whether or not malignant disease of the organ exists. Cases not infrequently occur in which the first section will reveal the presence of an undoubted carcinoma or sarcoma at a time when the clinical phenomena are insufficient to determine the

diagnosis, and at other times even when they are such as apparently to justify the conclusion that the dis-

FIG. 45.

Section through a blood-clot from the uterus after abortion, showing transverse and longitudinal sections of chorionic villi. (After Orth.)

ease is benign. Often, however, in cases in which the clinical indications are doubtful, the results of a microscopical examination are also not positive, and in such cases the course of procedure should be determined upon only after all the phenomena concerned, both clinical and pathological, have received due consideration.

Many unfortunate errors in diagnosis have resulted from the tendency of pathologists to rely too much on isolated signs in the sections and to base a diagnosis

of malignant disease on a single abnormality, such, for instance, as atypical gland-tubes, variations in the size of the epithelial cells in the same tubule, the occurrence of solid columns of epithelial cells, the irregular

Fig. 46.

Adeno-carcinoma of the uterine body. (After Orth.)

branching of the glands, and certain alterations in the stroma. It has been shown that any one or several of these conditions may occur in endometritis or associated with benign neoplasms, such as a simple polypus or a myoma. Again, the occurrence of gland tubules within the muscle is not pathognomonic of malignancy, for they have not rarely been found to penetrate thus far in myomatous disease or even under normal conditions. It may be accepted as a fairly safe rule for guidance that, except in those cases in which

definite cancer nests can be seen in the stroma between the glands, it is not justifiable to diagnose positively carcinoma of the uterus from these microscopic sections alone, unless the new growth can be seen invading the muscle and causing it to disappear before it. Fig. 46. But while a positive diagnosis can rarely be

FIG. 47.

Epithelioma of the cervix. (After Orth.)

made, the existence of many suspicious changes in the mucous membrane will often warrant the conclusions on the part of the pathologist which when controlled by the study of the symptoms which the patient presents will enable the operator to decide what to do. On the

other hand, in cases which from a clinical stand-point strongly suggest malignancy, but in which the tissues obtained by curetting yield no suspicious pieces whatever, needless operations may oftentimes be prevented. Sections from the cervix are often particularly puzzling, and all the different possibilities—erosions, congenital anomalies, benign hyperplastic growths, various forms of inflammation, as well as neoplasms—have constantly to be borne in mind. Fig. 47. Cullen's work, entitled "Cancer of the Uterus," deals admirably with the whole question, and will be found invaluable as a book of reference for the working gynæcologist.

Examination of Cyst Contents.—On account of the danger which accompanies it, exploratory puncture of abdominal cysts is now seldom resorted to for purposes of diagnosis, and since an abdominal section even for exploration has been rendered a safe procedure, it is not now necessary to depend so much upon the examination of the fluid from cysts to aid us in diagnosis. But, apart from the fact that the exact character of the contents of cysts of different origins must always be of interest, there are still occasions when useful, practical data for diagnosis and prognosis can be obtained from these examinations. In not a few abdominal cysts even an exploratory laparotomy will not always clear up our doubts as to the origin of the tumor where it is densely adherent to neighboring structures; and cysts of the bile-ducts, pancreatic cysts, and the like often go unrecognized or are misnamed when a careful physical, chemical, and

microscopical examination of their contents might suffice to correct the mistake. The examination should be carried out by means of the ordinary methods; the color, odor, reaction, and specific gravity should be carefully noted, and the quantity of albumin, sugar, and biliary bodies, if any of these be present, should be accurately ascertained. Less stress is now laid upon the significance of the presence of paralbumin and metalbumin or pseudomucin (Hammarsten, Scherer) since the irregularity and inconstancy of their occurrence in ovarian cysts and their occasional appearance in other fluids have been pointed out. The tests for these substances, however, are not difficult to carry out, and the results obtained when considered together with the other characters of the fluid may be of help for a differential diagnosis. The striking power of coagulation possessed by the fluid from fibro-cystic tumors of the uterus is familiar to all.

The microscopic examination of the sediment obtained by centrifugalization or by permitting the fluid to stand for a few hours in a conical glass may be positive. The various forms of cells—blood-corpuscles, pus-cells, or epithelial cells—present should be noted. The "budding cells" to be seen in the fluid which has been in contact with a cancerous peritoneum are quite characteristic and of some diagnostic value, although by no means pathognomonic. The presence of crystals of cholesterin, of echinococcus hooklets, or of renal elements may help to clear up the case. The walls and the contents of dermoid cysts can

usually be recognized by the naked-eye examination alone.

Autopsies.—Besides the careful routine examination of all organs and parts of organs removed at operations, the surgeon should try to obtain autopsies, where it is at all possible, on the cases which die while under his care. The importance of such examinations for an appreciation of the frequency of infection after operations has already been insisted upon, and any one who performs many operations and yet states that he "has had no opportunities of studying infection since the introduction of an aseptic or antiseptic technique," is either deceiving others or himself.

The autopsy in a case of infection is not by any means completed when the cause of death has been determined. Each case should be carefully studied for itself; the causal micro-organisms should be separated and identified; the portal by which the infectious agent entered the system should, if possible, be determined; its course and the mode of its extension to other parts should be followed, and any part played by concomitant diseases of heart, liver, kidneys, etc., in predisposing to infection, should be considered. In cases in which death has occurred without any apparent infection, the surgeon or pathologist should satisfy himself by bacteriological methods that there really has been no bacterial invasion. Partial and incomplete autopsies are, of course, better than none; but a little tact will usually gain the necessary permission for a complete autopsy, which should be made as soon as possible after

death and before putrefactive changes have taken place, so that all the organs may be carefully worked up. Only in this way can a knowledge of the correlation of diseases and of the interdependence of pathological changes within the pelvis and those elsewhere in the body be satisfactorily obtained. Only when the gross appearances of all organs have been carefully studied and described, when the tissues have been examined microscopically both in a fresh state and after being hardened and stained, and a complete bacteriological examination has been made, can we feel that we are in a position to pronounce judgment upon the case. The difficulties in the way of a thorough understanding of some cases which have been thus thoroughly studied, are sometimes great, and this very fact should make us all the more unwilling to be satisfied with the crude opinions founded upon imperfect and incomplete autopsy work.

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A.

B.

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G.

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P.

R.

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THE END.

NAME	DATE DUE
Blaisdell	ret. Dec. 3, 1913
Miss Walsh	ret. May 6, 1914
Miss Hogue	ret. Sept. 1914
Miss Joninon ret.	Aug. 16, 1915
F. G. Maggs. ret.	Apr. 19, '17
T. T. Shea. ret.	April 19, 1917
A. G. Magee ret.	May 7, 1917
F. Berry, ret.	Mar. 7, 1918
J. A. Simpson ret.	May 7, 1
D. J. Boyd	SEP 27 191
H. N. Thompson	
J. M. Kenney	APR
Pierrot S.G. III	